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Construction Engineering Research Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

Process and Energy Optimization Assessment

Tobyhanna Army Depot, PA

Mike C.J. Lin, Alexander M. Zhivov, Alfred Woody, Curt Bjork, Walter P. Smith, Michael J. Chimack, and Robert A. Miller

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Mike C.J. Lin and Alexander M. Zhivov

Construction Engineering Research Laboratory
PO Box 9005
Champaign, IL 61826-9005

Alfred Woody

Ventilation/Energy Applications, PLLC
Rochester Hills, MI 48309

Curt Bjork

Curt Bjork Fastighet & Konsult AB, Sweden

Walter P. Smith

Energy Technology Services International
Candler, NC 328715

Michael J. Chimack and Robert A. Miller

Energy Resource Center
University of Illinois at Chicago
Chicago, IL 60607-7054

Final Report

Prepared for Tobyhanna Army Depot, PA

Abstract: In February 2005, a team of expert consultants lead by researchers from the Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) performed a Level I Process and Energy Optimization Assessment (PEOA) at Tobyhanna Army Depot (TYAD) to identify process, energy, and environmental opportunities that could significantly improve the installation's mission readiness and competitive position. This assessment is a part of showcase studies at four sites selected by the Army Materiel Command to demonstrate energy reduction opportunities at industrial organic facilities and to promote the "Lean" concept and more efficient operations. The Level I analysis considered plating, painting, machining, welding, and mechanical repair shops, building envelope, heating, ventilation, air conditioning, and lighting. This report gives detailed results of the Level I study. The study recommended 40 (and economically quantified 22) process and energy improvement projects. An estimated $38.1M investment to implement these 22 projects at TYAD could achieve annual savings of $8.2M with an average simple payback of 4.6 years. If cogeneration (requires a very high capital investment and has a long payback time) is excluded, then the savings is about $1.6M with a capital investment of approximately $2.1M, indicating an average simple payback period of 1.3 yrs.

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Preface

This Assessment is a part of showcase studies conducted by CERL at four sites (Rock Island Arsenal, Corpus Christi AD, Tobyhanna AD, and Tobyhanna AD), which were selected by the Army Materiel Command to demonstrate energy reduction opportunities at industrial organic facilities and to promote the “Lean” concept and ways how to render these facilities more efficient. This study was conducted for Tobyhanna Army Depot (TYAD) under Project Requisition No. 0409684, “Process Energy Optimization Assessment,” via MIPR No. 4LFA04732B. The technical monitor was John Billack, Electrical Engineer, Directorate of Public Works, Tobyhanna Army Depot.

The work was managed and executed by the Energy Branch (CF-E) of the Facilities Division (CF), Construction Engineering Research Laboratory (CERL). The CERL principal investigators were Dr. Alexander Zhivov and Dr. Mike C.J. Lin. Appreciation is owed to John Billack (TYAD) for his coordination of the TYAD team and to the TYAD DPW and Production staffs, who contributed significantly to the information gathering. Major contributors to the study were Alfred Woody (Ventilation/Energy Applications, PLLC), Curt Bjork (Curt Bjork Fastighet & Konsult AB, Sweden), Walter P. Smith (Energy Technology Services International), Bruce Martin (PlymoVent Corporation), Michael Chimack and Robert A. Miller (Energy Resource Center, University of Illinois at Chicago). Dr. Tom Hartranft is Chief, CEERD-CF-E, and Mr. L. Michael Golish is Chief, CEERD-CF. The associated Technical Director is Paul A. Howdyshell CEERD-CV-T. The Director of CERL is Dr. Ilker R. Adiguzel.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Commander and Executive Director of ERDC is COL James R. Rowan, and the Director of ERDC is Dr. James R. Houston.

Unit Conversion Factors

Multiply	By	To Obtain
acres	4,046.873	square meters
cubic feet	0.02831685	cubic meters
cubic inches	0.00001638706	cubic meters
degrees (angle)	0.01745329	radians
degrees Fahrenheit	(5/9) x (°F – 32)	degrees Celsius
degrees Fahrenheit	(5/9) x (°F – 32) + 273.15.	kelvins
feet	0.3048	meters
gallons (U.S. liquid)	0.003785412	cubic meters
horsepower (550 ft-lb force per second)	745.6999	watts
inches	0.0254	meters
kips per square foot	47.88026	kilopascals
kips per square inch	6.894757	megapascals
miles (U.S. statute)	1.609347	kilometers
pounds (force)	4.448222	newtons
pounds (force) per square inch	0.006894757	megapascals
pounds (mass)	0.4535924	kilograms
square feet	0.09290304	square meters
square miles	2,589,998	square meters
tons (force)	8,896.443	newtons
tons (2,000 pounds, mass)	907.1847	kilograms
yards	0.9144	meters

1 Introduction

Background

The Army has maintained a nearly continuous presence in Tobyhanna, PA since 1912 when the site was first used as a field artillery training camp. Tobyhanna Army Depot (TYAD) opened on 01 February 1953, following 2 years of construction, and has since served our nation for over 50 years. TYAD is the largest, full-service electronics maintenance facility in the Department of Defense (DOD). The Depot's mission is total sustainment, including design, manufacture, repair and overhaul of hundreds of electronic systems.

During the past few years, the U.S. Army Corps of Engineers, Construction Engineering Research Laboratory (ERDC-CERL) has been involved in process and energy optimization to help DOD installations meet energy efficiency and environmental compliance requirements and to create an improved work environment through a "Process and Energy Optimization Assessment" (PEOA). The key elements that guarantee success from a PEOA are: (1) the involvement of key facility personnel, who know what the problems are and where they are located, and who have already thought of many solutions; (2) the facility personnel sense of "ownership" of the ideas, which in turn develops a commitment for implementation; and (3) the PEOA focus on site-specific, critical cost issues, which, if solved, will make the greatest possible economic contribution to facility's bottom-line. This work would complement the Army Materiel Command's ongoing implementation of its "Lean Thinking & Six Sigma" strategy.

This study is one of a series of similar studies conducted at four Army Materiel Command installations to identify process and energy systems performance improvement opportunities, to develop workspace consolidation strategies, and to work with base engineers and contractors to apply these strategies. After these improvements, the site may become a showcase example for other DoD production facilities.

Objectives

The main objective of this study was to conduct a process and energy optimization assessment to enhance operational performance in process and building energy systems at TYAD. A secondary objective was to identify opportunities to increase efficiency and reduce pollutant emissions using the process energy and pollution reduction (PEPR) methodology and the process optimization guide, both of which are tools developed by ERDC-CERL.

Approach

In February 2005, a team of Army researchers and expert consultants performed a PEOA at TYAD to identify process, energy, and environmental opportunities that could significantly improve the installation's mission readiness and competitiveness.

The three levels of process and energy analysis differ in the objectives, scope, methodology, procedures, required instrumentation and approximate duration:

Level I. Preliminary energy and process optimization opportunity analysis (walk-through review; no instrumentation with basic analysis). A Level I audit usually takes from 2 to 5 days and allows identification of the dollar potential for process improvements and energy conservation to the bottom-line. No engineering measurements are made. The existing processes are challenged, and new practices and new technologies are considered. A Level I Audit would normally be followed by a Level II process audit to verify the Level I assumptions and to more fully develop the ideas from the Level I screening analysis.

Level II. Energy and process optimization analysis geared toward funds appropriation (calculated savings; partial instrumentation with cursory analysis). A Level II study typically takes 5 to 10 times the effort of a Level I, and could be accomplished over a 2- to 6-month period, depending on the scope of the effort. The Level II effort includes an in-depth analysis in which all assumptions are verified. The end product from Level II is a group of "appropriation grade" process improvement projects for funding and implementation.

Level III. Detailed engineering analysis with implementation, performance measurement and verification (M&V) assessment; fully instrumented diagnostic audit; 3 to 18 months in duration.

Work was proposed to proceed in three phases. Phase 1 focused on review of existing energy-demanding system requirements and on development and analysis of potential energy saving opportunities. Phase 2 will inspect the existing support equipment and develop renovation plans. Phase 3 will verify implementation monitoring and savings. The Phase 1 study described in this report will result in a detailed scope of work for Phase 2, which can begin after sponsor's approval.

Scope

This Phase 1 energy assessment evaluated several production processes, such as plating, painting, sand blasting, machining, welding, electronic and mechanical repairs, etc. Building envelope, HVAC, lighting, roofing, and the compressed air systems as well as boiler and chiller plants were also examined. This work assumes that technical solutions are possible and that economic calculations are approximations (accurate to ±20 percent). Only limited engineering measurements were made.

Mode of Technology Transfer

The results of this work will be presented to TYAD for their consideration in pursuing follow-on Phase 2 work. It is anticipated that the results of this work will contribute to further awareness of the AMC installations, and to Corps, District, and other Army installation personnel via implementation through associated regional Installation Management Agency (IMA). It is also planned to disseminate this information through workshops, presentations, and professional industrial energy technology conferences.

This report will be made accessible through the World Wide Web (WWW) at URL:

http://www.cecer.army.mil

2 Process and Energy Assessment at Tobyhanna Army Depot

TYAD Energy Conservation Program

Tobyhanna Army Depot has a proactive energy program that strives to meet its annual energy reduction goals. These goals are parts of a 20-year DOD energy reduction plan from FY85–FY05 and a new 25-year plan from FY85–FY10. The ultimate goal for the depot, in accordance with the Executive Order 13123 of 1999, is to reduce "facilities" energy (i.e., Btu's from natural gas, electricity, and fuel oil) by 30 percent, FY85-FY05 and by 35 percent by 2010 relative to 1985. With respect to the "mobility" energy component (gasoline), the goal was a 5 percent reduction during the period FY85–FY95. Reporting of a "process" component by the depot was discontinued in FY92 by AMC. To allow for installation growth, the facilities goal is normalized with respect to energized building area, and expressed as MBtu/k sq ft. The aim of the depot energy program is to reduce energy consumption by promoting energy conservation, the construction of new, energy efficient, facilities, promoting energy improvements, and development/research of new technologies or programs (such as Energy Savings Performance Contracts [ESPC]). Specific ways in which the depot is striving to achieve reductions include a number of measures taken as a result of TYAD entering into an ESPC (worth $32 million dollars) with HEC Inc.

This ESPC will safeguard the depot's mission by providing reliable heat and process steam, and efficient lighting. It achieved substantial reductions in energy consumption (42 percent), water usage (20 percent), and air emissions (60 percent) to ensure the depot's compliance with Executive Order 13123. The project replaced an aging, central coal-fired heating plant with decentralized natural gas heat and upgraded inefficient lighting throughout the depot's industrial zone. It also included an Energy Monitoring Control System to optimize heating, ventilation, and air conditioning systems. The high-efficiency decentralized heating system has three major components: installation of decentralized boiler plants, construction of the natural gas pipeline, and modifications to existing heating systems (i.e., installation of air-rotation units for heating the general purpose warehouse bays). Inspection and repair/replacement of steam traps at selected buildings was recently completed. This will also help maximize condensate returned to the decentralized boilers.

The electric submeter readings (approximately 135), and the natural gas meters (21) are monitored monthly to enable Environmental Management Division (EMD) and users to spot irregular consumption.

Technical review for energy considerations at the various design stages of Facilities Engineering Projects and Major Construction, Army building projects (high efficiency lighting and motors, insulation, etc.). Periodic reminders to conserve energy via tips published in the Reporter (such as the article on turning off unneeded lights and equipment) or broadcast on the public address system. These usually remind employees of the impact energy conservation can have on the Net Operating Result and their own possible monetary award. Energy walk-through inspections are performed by the EMD at different building locations on a monthly basis.

Analysis of Energy Supply, Consumption, and Costs

In FY04, TYAD consumed 58,763,000 kWh of electricity with an annual average daily load of 6,690 kW. Maximum kW reached in FY04 was 10,796 kW while the maximum kW ever reached since FY96 was 10,886 kW (occurred in FY05). Total annual electricity cost was $3,148,978 with an average cost of $0.054/kWh. Electricity is purchased from PPL Electric Utilities Corporation under LP5 General Service Rate that has a demand charge of $4.4573/kW and other distribution and assorted transition charges. Electricity energy charge starts from 3.9755 cents/kWh with a couple of step rate reduction as usage increases and reaches a certain level (about 15 percent reduction at each step). During the same period, the installation used 323,088 MMBtu (313,373 KCF) of natural gas, at a cost of $2,094,330 (Table 1). Average cost for natural gas is about $6.31/MMBtu. Natural gas is purchased through Sempra Energy Trading contract (awarded by the Defense Energy Supply Center), which had the following costs (in December 2004):

- EPA Firm Gas: $8.8093/MMBtu
- FFP Firm Gas – Firm Fixed Price Conversion: $6.66/MMBtu
- Remarket of Excess Gas: $7.3981/MMBtu.

TYAD spent approximately $5.5 million for energy (excluding gasoline and Diesel fuel) for the entire year at an average cost of $9.73/MMBtu. TYAD total energy use by type is shown in Figure 1 for FY03 and in Table 1 for both FY03 and FY04. From FY03 to FY04, the portion of natural gas usage decreased by about 3.2 percent while electricity use increased by 3.6 percent with the rest of the fuel portions remain at the similar levels.

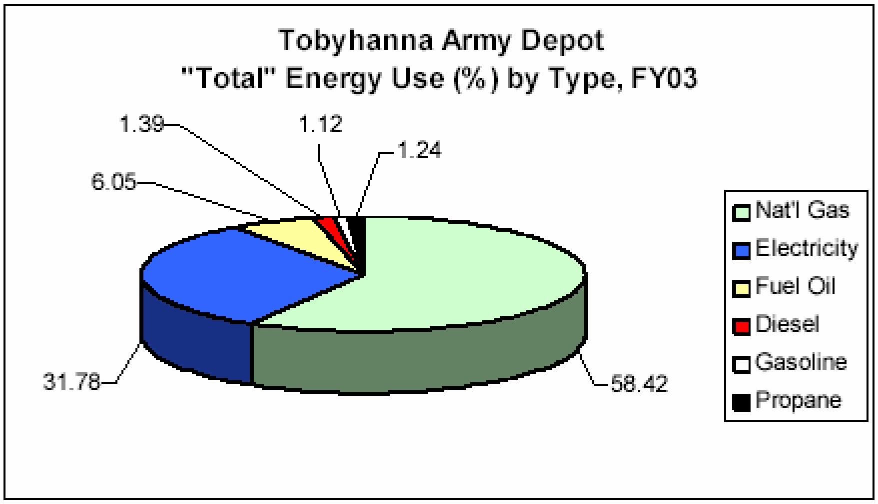


Figure 1. Total energy use by Type (FY03).

Table 1. Total energy use by type (FY03 and FY04).

	FY03	FY04	Increase
Nat. Gas	58.42%	55.21%	-3.21%
Elec.	31.78%	35.34%	3.56%
Fuel Oil	6.05%	5.94%	-0.11%
Diesel	1.39%	1.25%	-0.14%
Gasoline	1.12%	1.17%	0.05%
Propane	1.24%	1.09%	-0.15%

The plant energy systems convert the kWh of electricity and Btu of fuel into various productive utilities such as compressed air, steam, and shaft power to support various end uses. These annual purchased energy costs and variable unit costs are used as the “Cost Basis of Savings” (CBoS) for the economic analysis of Energy Conservation Measures (ECMs). Table 2 lists TYAD building utilities consumption (excluding family housing) for FY04 including electricity, natural gas, propane, and fuel oil distillate (FSD).

Table 2. TYAD FY04 Utilities unit costs, excluding family housing (Source: ACSIM HQRADDS).

Utility	Month	Facility Reporting Unit	Cost ($)	MBtu (Rounded)	$/Unit	$/MBtu
ELEC	Oct-03	4,114MWh	227,504	14,041	55.30	16.20
(MWh)	Nov	4,230	230,112	14,437	54.40	15.94
	Dec	4,695	247,239	16,024	52.66	15.43
	Jan-04	4,728	254,366	16,137	53.80	15.76
	Feb	4,846	259,406	16,539	53.53	15.68
	Mar	5,163	268,579	17,621	52.02	15.24
	Apr	4,963	263,138	16,939	53.02	15.53
	May	4,550	249,295	15,529	54.79	16.05
	Jun	4,801	258,726	16,386	53.89	15.79
	Jul	4,796	261,670	16,369	54.56	15.99
	Aug	5,140	270,827	17,543	52.69	15.44
	Sep	5,145	270,884	17,560	52.65	15.43
	FY04 Total	57,171	3,061,746	195,125	53.55	15.69
NAG	Oct-03	21,507KCF	127,354	22,174	5.92	5.74
(KCF)	Nov	30,258	208,525	31,196	6.89	6.68
	Dec	45,971	311,290	47,396	6.77	6.57
	Jan-04	59,968	409,629	61,827	6.83	6.63
	Feb	50,939	342,062	52,518	6.72	6.51
	Mar	43,244	307,570	44,585	7.11	6.90
	Apr	29,235	182,633	30,141	6.25	6.06
	May	10,886	72,325	11,223	6.64	6.44
	Jun	5,275	33,326	5,439	6.32	6.13
	Jul	4,866	31,674	5,017	6.51	6.31
	Aug	5,396	34,696	5,563	6.43	6.24
	Sep	5,828	33,246	6,009	5.70	5.53
	FY04 Total	313,373	2,094,330	323,088	6.68	6.48
PPG	Oct-03	6,353 Gal	5,591	604	0.88	9.26
(gallons)	Nov	7,813	7,036	742	0.90	9.48
	Dec	12,455	10,960	1,183	0.88	9.26
	Jan-04	9,787	8,613	930	0.88	9.26
	Feb	16,517	14,535	1,569	0.88	9.26
	Mar	8,685	7,643	825	0.88	9.26
	Apr	552	648	52	1.17	12.46
	May	804	707	76	0.88	9.30
	Jun					
	Jul					
	Aug					

Utility	Month	Facility Reporting Unit	Cost ($)	MBtu (Rounded)	$/Unit	$/MBtu
	Sep					
	FY04 Total	62966	55733	5981	0.89	9.32
FSD	Oct-03	168 BBL	6,576	979	39.14	6.72
(BBL)	Nov	752	27,915	4,380	37.12	6.37
	Dec	710	26,380	4,136	37.15	6.38
	Jan-04	1,375	50,679	8,009	36.86	6.33
	Feb	965	35,698	5,621	36.99	6.35
	Mar	809	29,998	4,712	37.08	6.37
	Apr	513	19,182	2,988	37.39	6.42
	May	223	8,585	1,299	38.50	6.61
	Jun	128	5,080	746	39.69	6.81
	Jul	102	4,157	594	40.75	7.00
	Aug	65	2,812	379	43.26	7.42
	Sep	138	5,479	804	39.70	6.81
	FY04 Total	5948	222541	34647	37.41	6.42
FY04Total*			$5,434,350	558,841		9.72
*Excludes family housing						

Unit Cost Calculations and CBoS

Since specific energy conservation measures focus on some type of end-use utility like compressed air, shaft power, lighting, etc. to support a process, the team needed a method to translate reduced consumption at the end use back to lower electricity usage or lower fuel consumption and the associated cost savings. As a result, researchers provided the team with translation formulas to convert incremental end use consumption back to the energy source and ultimately back to dollar cost, or the CBoS. Table 3 lists the cost values for an incremental unit of a utility and the underlying equation that derives this amount. Labor costs were estimated at $75/hr for industrial services personnel.

Table 3. Cost Basis of Savings (CBoS)

Utility or cost factor	Derivation and Cost
1. Electricity	$0.056/kWh including both energy and demand. Demand charge = $4.4573/kW-month Energy charge = 3.9754 cents/kWh $490/kW-yr (combined energy and demand) = 1 kW used for 8,760 hrs/yr $53.49/kW-yr (demand only)
2. Horsepower	1 hp x 0.746 kW/Hp x 8760hrs/yr x $0.056/kWh = $366/hp-yr
3. Natural Gas	$6.877/MMBtu ($6.67/kCF; energy content 1,031Btu/kCF)
5. Steam	100 psig, 338 °F saturated steam, 1189Btu/lb $12.97/klb (consider only natural gas cost and 65% boiler efficiency)
6. Water and Sewer	Water = $235,700/yr = 83,585kgal/yr @ $2.82/kgal Sewer = $312,010/yr = 68,900/kgal @ $4.528/kgal

PEOA Team and Schedule

The TYAD PEOA took place over a 5-day period, from Monday to Friday, 21-25 February 2005. Table 4 lists the team members and their affiliations. Table 4 shows how the 5-day assessment process was organized by time, activities, and location to ensure that all of the critical areas in the scope of work were covered and that the process of the information collection, brainstorming sessions, and briefings to the management were built-in to the TYAD personnel busy schedules. The PEOA team briefed its preliminary findings to the TYAD management and engineering staffs 25 February 2005.

Table 4. PEOA participants list.

Tobyhanna Army Depot	
John Billack	George Rittenhouse
James Brandle	Paul Roberts
Keith Burns	Bill Rutecki
Mike Crawford	Michael Rusinko
Randy Didier	Harry Savers
Terry Hincken	Ron Scarnulis
Frank Kaczmarek	Herb Shirey
Edward Kovaleski	Randy Simpson
Jim Moore	Jim Smith
Coleman Nea	Patrick Tierney
Joe Pearson	Charles Valencia
	Tom Wildoner

ERDC-CERL
Mike Lin
Alexander Zhivov

University of IL at Chicago
Jonathan Aardsma
Mike Chimack
Noel Corral
Robert Miller

VEA
Alfred Woody

CBF&K
Curt Bjork

ETSI
Walt Smith

PlymoVent
Bruce Martin

Table 5. Five-day schedule, TYAD PEOA.

Monday (21 Feb 05)	
9:00-9:30	Security Process and Badges
9:30-12:00	Guided Depot Tour
12:00-13:00	Lunch
13:00-17:00	Complete Tour & Pre-assessment preparation (Building 18)
Tuesday (22 Feb 05)	
8:00-8:30	Introduction (John Billack)
8:30-9:30	Environment Overview – Randy Didier/Jim Brandle
9:30-11:00	Mission Overview – Ed Kovaleski
	Current Project – Terry Hincken
	Shops Views / Discussion on issues – Mike Crawford, Paul Roberts, Randy Simpson
11:00-11:30	Systems Integration & Support Mission – Director Frank Kaczmarek Presentation
11:30-12:30	Lunch
12:30-16:00	Group One Assessment – Plating/Painting
	Group Two Assessment – Welding/Woodworking
16:00-17:00	Assessment Team Ideas Generation
	Building drawing access
Wednesday (23 Feb 05)	
8:00-9:00	Planning & preparation
9:00-11:30	Building Drawings Access
	Group One Assessment – Boiler/HVAC Escort: Joe Pearson
	Group Two Assessment – IOF Revisit Escort: Chas. Valencia
11:30-12:30	Lunch
12:30-16:00	Building Drawings Access
	Group One Assessment – Buildings 1C & 9
	Group Two Assessment – Buildings 10, 14 &23
16:00-17:00	Assessment Team Ideas Generation
	Building drawing access
Thursday (24 Feb 05)	
8:00-9:00	Planning & preparation
9:00-11:30	Building Drawings Access
	Additional information collection
11:30-12:30	Lunch
12:30-17:00	Building Drawings Access
	Assessment Team Ideas Generation
Friday (25 Feb 05)	
8:00-10:00	Presentation preparation
10:00-11:30	Assessment Team Presentation (Lackwanna Room) & discussion
11:30-12:30	Lunch
12:30-14:00	Close Out and Adjourn

3 Tobyhanna Army Depot Assessment Results

This Chapter presents assessment results and provides recommendations for the operations of TYAD industrial processes and building energy systems.

Results of the Level I analysis are listed by associated production processes and systems as shown in Table 6.

Table 6. Evaluated processes and systems

1. Plating (PL)	4. Building Envelope (BE)	7. Shot Blasting (SB)	10. Compressed Air (CA)
2. Painting (PN)	5. Building HVAC (BH)	8. Lighting (LT)	11. Cafeteria (CF)
3. Welding (WD)	6. Chiller Plant (CP)	9. Boiler Plant (BP)	12. Site Wide Misc. (SW)

Plating Area

Plating Shop (Figure 2) is located in Building 1E, Industrial Operation Facility (IOF). Figure 3 shows the plating tank layout. There are more than one hundred plating/cleaning tanks in the shop to perform processes consisting of zinc phosphate coating, chromating coatings, hard and soft anodizing, and most electroplating processes for the purpose of precision coatings with various precious metals, also including buffing and polishing, in vapor disposition (IVD) and the electroless nickel process. Additional capabilities in the electroplating processes are as follows: nickel, silver, cadmium, copper, passivate, black magic, black oxide, tin, and non-gloss/dull nickel plating processes. TYAD also has the capability to do different color dye processes used with the hard and soft coat operations.

The production processes emit different acid mists, gases, and steam. Plating tanks are equipped with exhaust systems and contaminants are captured by going through scrubbers. Automated controls properly mix the chemicals, achieve and maintain correct temperatures, etc. Some tanks are heated to maintain required temperatures.

Figure 2. Plating Shop in IOF.

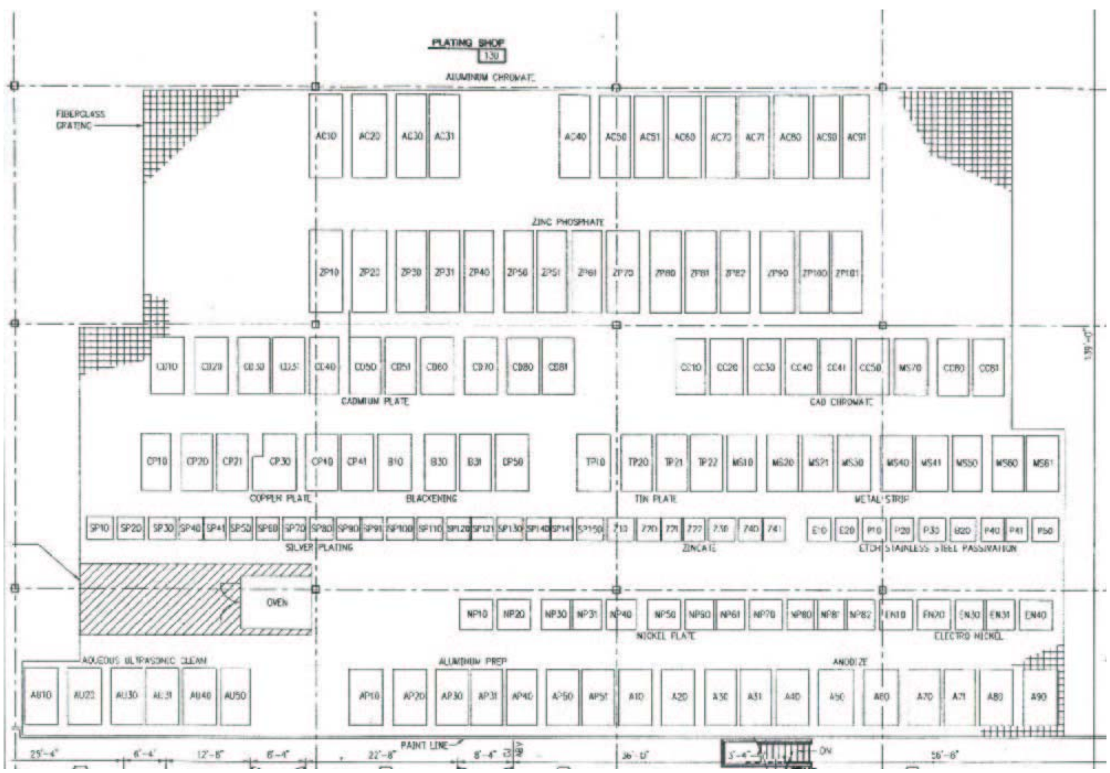


Figure 3. Plating tank layout.

Recommendations for Plating Operation

PL#1: Replace Existing Control System in the Plating Shop To Facilitate Pressure Control

Existing Conditions

The new Plating Shop in Building 1E, IOF was commissioned for operation starting in December 2003. From the viewpoint of the assessment team, it is a most impressive plating shop with respect to how it is operated and maintained. The air balance in the Plating Shop is to be controlled by a control system from Johnson Controls (see control panel in Figure 4). However, the control system was not working at the time of visit and, according to people working in the Plating Shop, it has never worked. This problem is not limited to the Plating Shop but, extends to other interconnected surrounding shops (the Paint Shop, Sand-Blasting Shop, and other areas). Since there is a large opening in the corner of the Plating Shop (Figure 5), air moves freely to or from the adjacent areas depending on the room air pressure in each area.

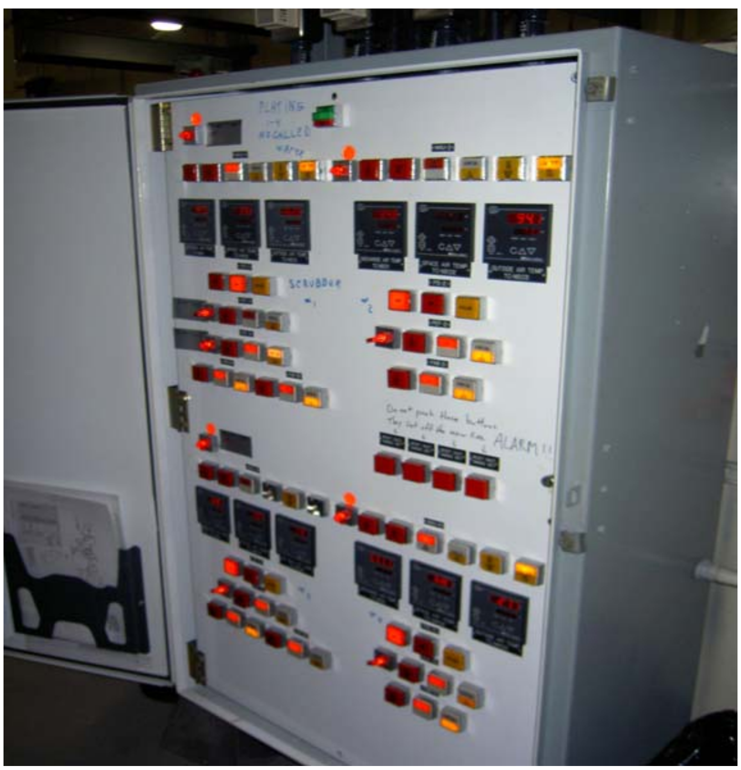


Figure 4. Plating Shop ventilation control panel.

Figure 5. Open door to plating area.

About one third of the plating tanks have a push-pull system, supplying air at one end of the tank and pushing it out at the other end (Figure 6). The exhaust from the plating tanks is cleaned in scrubbers and then discharge to atmosphere. There are four scrubbers with a total air flow of 143,000 cfm. The six roof-top makeup air units (MAU) have the capacity to supply a total of 174,000 cfm air to the Plating Shop. MAU#7 supplies air to the Sand-Blasting Shop. MAU #8 supplying air to the Paint Shop.

Figure 6. Plating tank push-pull exhaust system.

During working hours, every MAU and scrubber is running. Scrubber # 3 is always running while the other scrubbers are switched off during third shift and during weekends when some tanks are covered. The MAUs are never switched off. The MAUs run on 100 percent outdoor air, and thus demand a great deal of energy. During non-working hours, this means that the Plating Shop suddenly builds positive air pressure, which pushes air out to other areas of Building 1E.

During the assessment of the Plating Shop, researchers noted that the shop was under a very high negative pressure. A look at the roof explained why: MAU#3 was not running (reason unknown). MAUs # 1 and 2 were frozen and piles of ice were beneath them, as a result of broken steam coils (Figure 7), which were still leaking. As a result of these failures, the scrubbers were running and the MAUs could not create a correct balance with sufficient amounts of supply air.

Figure 7. Frozen MAU 2.

The high negative pressure also means that cold air is leaking into the Plating Shop from the outside, through doors, wall cracks, and also through the entrance with the bid door between the Plating Shop and the Sand-Blasting Shop, since there is no vestibule there. Cold airflow was apparent when this door was open. Electric unit heaters had been placed along the walls (Figure 8) to compensate for the cold air entry. The setpoint for all these units (10 kW each) was 100 °F; consequently, all the heaters were constantly running.

Figure 8. Electric unit heater.

Solution

Replace the existing control system with a new one. Install pressure sensors inside the Plating Shop and at the outside. Control MAUs at all times to match the exhaust air flow via the scrubbers, by keeping the Plating Shop slightly, not much, negative. Install VFDs on scrubbers, Push Air Blowers (PABs), and one MAU. Close the dampers for the push-pull system for those tanks that do not need the push-pull function. Control scrubber fans to keep a constant negative pressure in the exhaust duct, depending on how many tanks are connected to the pull system. Lock thermostats for electric unit heaters at 60 °F or less. They should only be used to prevent too low temperatures in the winter during non-working hours. Make sure that all MAUs are in good shape and working if needed.

During this work, consider this proposed solution: measure and make calculations of airflows in ever part of Building 1F and also in Building 1A. Make a pressure map, showing how large imbalances there are in different areas. Also, address those areas with respect to pressure control over the time of the day and the week (pressure sensors, VFDs on supply air units and, controlling exhaust fans).

Savings

The energy savings can be calculated considering the possibility of reducing the total airflow in the Plating Shop (not pushing and pulling at all tanks, and not running all MAUs all the time). The electric heaters today probably use electric energy worth close to $1,000/week during the heating season, totaling at least $30,000/yr potential savings. An outdoor air flow reduction of 50 percent, or approximately 70,000 cfm, can save heating energy worth $125,000/yr at a cost for Natural gas equivalent to $6.877/ million BTU and a boiler efficiency of 80 percent. Also, not constantly running the scrubber and MAU fans at full speed will result in energy savings. Total savings will potentially exceed $150,000. The actual savings will have to be calculated in Phase 2 when the applicability of the proposed solutions can be agreed upon with the Plating Shop management.

Additional savings will result from not pushing polluted Plating Shop air into other parts of IOF or 1A. This will greatly improve working conditions within the Plating Shop, by eliminating the draft, maintaining more even space temperature etc. Reducing running time will also lessen associated scrubber maintenance costs.

Investments

Estimated at less than $200,000 (including drawing the pressure map).

Payback

Less than 1.3 yrs.

PL#2: Recover Heat from Steam Vents in Building 1E To MAUs in Plating and Painting Shops

Existing Conditions

There is a steam plume on the roof of IOF (Figure 9) that comes from steam traps leaking fresh steam into a condensate return tank that is vented to the atmosphere. The plume is estimated to be at least 30 ft high. A 30 ft plume consists of 8 – 10k pounds of steam per hour. (It is possible that a plume that high to indicate a loss of more than 30,000 lb of steam per hr, but since the exact height of the plume was not measured, a moderate 8,000 – 10,000 lb/hr was assumed). At an estimated cost of $10/k pound of steam, this indicates a loss (wasted energy) worth $80 – $100/hour.

Figure 9. Steam plume from IOF roof-top.

Solution

Recover the heat from the steam into the MAUs on the roof, supporting the Plating Shop, Paint Shop, and also the Sand-Blasting Shop. Design a heat recovery system so that the heat can be used in one or several of the MAUs, thus saving on primary energy that is supplied to those MAUs today.

Savings

Savins from the recovery of heat from Steam Vents in Building 1E are estimated to be $80/hr during 6 months of heating season means $345,000/yr through that steam plume. There is some uncertainty of whether the steam plumes exist all the time but at least it was there every time that we checked during the energy assessment week.

Investments

Investments are yet to be calculated, are but estimated to be less than $100,000.

Payback

Within 1 year, probably much faster, within a couple of months.

PL#3: Repair Auto Start/Stop Controls for 4 Scrubbers (Johnson Controls Panel Board)

Existing Conditions

The Johnson Controls system for auto start/stop sequencer controls for the 4 scrubbers and make up air units (MAUs) has never worked. The start up/shut down sequence for each scrubber controls the pump (for example PEF-1), exhaust fan (PEF1), push air (PAB-1) and make up air (MAU @ 50hp each). The vast majority of the savings (92 percent) comes from reducing winter heating loads by turning off 3 of the MAUs.

Solution

Restore the JCI control system's functions to allow timely and efficient coordination of scrubber motor drives and corresponding MAUs. It appears the $40 million IOF plating shops engineering firm (Burns and McDonald), construction company (Bell Construction, Inc.) and the project managers all bear some responsibilities.

Savings

(75hp + 75hp + 40hp) x 0.746kW/hp x 1hr/day x 5days/wk x 50 wks/yr x
$0.056/kWh = $2.0k/yr
3 MAU x 50hp x 0.746kW/hp x 8 hrs/day x 5 days/week x 50 weeks/yr x
$0.056/kWh = $12.5k/yr
3 MAU x (1.08 x 100,000cfm x (70°F–30°F)) x 2,000hr/yr x $6.88/MMBtu
= $178.5k/yr
Total savings = $2.0k/yr + $12.5k/yr + $178.5k/yr = $193.0k/yr

Investments

Estimated cost to repair the auto start/stop controls is $30k.

Payback

$30k/($193k/yr) = 0.2 yrs

PL#4: Install a VFD on Scrubber PEF-3

Existing Conditions

Scrubber PEF-3 operates 24 hr x 7 day x 50 weeks/yr to exhaust air from plating tanks that are not practical to cover during non-production time (6,500 hrs/yr). It is believed that the flow rates for scrubber #3 can safely be reduced by 10 percent during scheduled non- production periods.

Solution

Install a VFD on scrubber PEF-3, which operates 24x7 and set non-production time flow rate to 90 percent of current setting.

Savings

hp savings = 50hp x (90% loaded / 90% efficient) x 0.746kW/hp x ((8,760 hrs/yr – (9hrs/day x 5 days/week x 50 weeks/yr)) x (1.0 – 0.9^3 savings) x $0.056/kWh = 50 hp x 0.746kW/hp x 6,500hrs/yr x 27.1% savings x $0.056/kWh = $3.7k/yr
MAU savings = 50hp x 0.746kW/hp x 6,500 hr x 100% savings x $0.056/kWh = $13.8k/yr
MAU heat = 1.08 x 33,000cfm x (70F – 30F) x 10% x 6,500hrs/yr x $6.88/MMBtu÷$10^6$ Btu = $6.4k/yr
Total savings = $3.7k/yr + $13.8k/yr + $6.4k/yr = $23.9k/yr

Investments

Purchase and install 50 hp VFD = 50hp x $200/hp = $10.0k
One time evaluation at 90% flow = $10.0k
Total cost = $10k + $10k = $20k

Payback

$20k/($23k/yr) = 0.9 yrs

Painting Operation in Building 1E (IOF)

TYAD has state-of-the-art painting facilities located in Building 1E, IOF. There are blasting booths and sanding rooms large enough for 40-ft trailers. Paint booths are available to accommodate any items being coated or refinished. Some paint booths have the capability to paint and bake finished items.

Painting operations include initial paint preparation such as acid pre-wash and priming, final painting, which includes all VOC compliant coatings to include epoxies, alkyd enamels and (CARC) polyurethane in both single and three-color camouflage patterns, undercoating, stenciling, spot painting, silk screening, filled engraved lettering, powder coating, chemical agent resistant coatings (CARC) and other related operations on components of overhaul and fabrication workload. Production painting is performed on components of overhauled systems and fabrication workload. Powder coating is also applied to specialty items that have been overhauled. All coatings used are CARC. Refinishing involves removal of paint coatings by chemical stripping, steel and aluminum oxide blasting to include sanding and grinding, as well as steam cleaning, power washing, polycoating irradiating and masking prior to painting and it can accommodate end items from shelters, vans, trucks, trailers, generators and antennas, in excess of 40 ft in length (Figures 10 and 11).

Painting involves all major components of the following programs:

- SATCOM Systems
- FIREFINDER Systems
- Power Units
- Major Shelters & Van Configurations
- All Fabrication Workload
- Equipment unique to TYAD's mission is listed below:
- Computerized Stenciling Machine
- Filled Engraved Lettering
- Portable Powder Coating Unit
- Visual and Magnification Monitor for Vision Impaired Employees
- Pressurized and HVLP Equipment for CARC and Epoxy Applications
- HGPA Vacuum System
- Undercoating Equipment
- Engraved Filling Machine.

Figure 10. Antenna component painting.

Figure 11. Preparing shelters & generators for paint.

Recommendation for Painting Operation in Bldg. 1E

PN#1: Heat Recovery from Baking Ovens in Painting Shop Bldg. 1E

Existing Conditions

There are seven baking ovens in the Paint Shop in Building 1E. Parts are painted in one of eight booths and then they are moved to an adjacent oven to dry the paint and begin the curing process. Two of the ovens are conveyor types where the parts are moving through the oven space. The other five ovens have parts placed inside them and someone must remove the parts when the drying cycle is complete.

The larger conveyor ovens exhaust 975 cu ft/minute (CFM) each of heated air. The oven temperature is 211 °F in the 1st oven zone and 146 °F in the 2nd zone. The smaller ovens are exhausted at a rate of 300 CFM each. The temperatures maintained in those ovens are 200 °F in the 1st oven zone and 176 °F in the 2nd zone.

Outside air brought into this space is heated by steam. Some of the heat in the oven exhaust could be recovered and save steam energy.

Solution

Pass the oven exhaust through an air-to air heat exchanger for heat recovery. The heat exchanger will bring outside air into the Paint Shop for use as makeup air for the oven exhaust. The heat exchanger will have a fan and filters for the supply air.

Savings

The estimated efficiency of the heat recovery unit is 60 percent. The average winter temperature is 32 °F. The estimated leaving temperature is 183 °F.

The amount of heat recovered = 1.08 x 3950 CFM (183 – 32) x 0.6 efficiency. x 2000 hrs/yr = 773 MM Btu/yr
Heating cost savings = 773 MM Btu x $10.58 / MMBtu = $8200 per yr

Investments

The estimated cost for a 3750 CFM make up air unit having a heat recovery unit is estimated to be $20,000

Payback

$20,000/($8,200/yr) = 2.4 yrs

The payback period for the heat recovery unit is 2.4 yrs.

PN#2: Install Variable Frequency Drives on Paint Booth Fan Motors

Existing Conditions

There are currently eight paint booths in Building 1E. Each booth has a supply air system that provides air to the booth. There is also an exhaust system that removes air from the booth. With one exception, both fans of these systems are fixed drive and thus the air flow can vary due to changes in system static pressure. As filters become loaded with dirt the static pressure increases. This causes a drop in air flow that affects the air balance between the supply and exhaust in each booth. Several booths were observed to have fumes present outside their doors. These fumes were caused by more supply air being sent to the booth than is removed or exhausted. As a result, excess air seeps out of the booth through openings around the booth door.

One booth already has variable speed drives on the supply and exhaust fan motors. This booth operates much smoothly without leaking fumes.

Solution

Install variable speed drives on all seven booth supply and exhaust fan motors. Set these fans up to be controlled such that there is always more exhaust than supply air. Also the total air flow can be reduced to 80 FPM through the exhaust air openings without affecting the quantity of overspray. When paint spraying is being accomplished the painter is wearing an air supplied protective face mask. This person is not being exposed to any fumes arising from the painting operation.

Savings

The fan motors for these paint booths are 30 horsepower for each booth's supply and 15 horsepower for each exhaust system. Slowing the fans to 80 percent of their current flow will save the cube of the speed reduction or approximately 50 percent of the fan motor energy use. These fans run one shift per day or approximately 2000 hrs/yr.

Electrical savings = 7 booths X (30 + 15) Hp X 0.5 X 2000 hrs/yr X 0.746 kW/hp
= 235,000 kWh /yr
Electrical cost savings = 235,000 kWh/yr X $0.056/kWh = $13, 200
Heating Energy Savings = 1.08 x 7 booths x 25,000 CFM booth x 45 °F rise x
X 20% x 800 hours/yr
= 1,360 million Btu/yr
Heating Energy Savings = 1,360 million Btu/yr x $6.877 / million Btu x 1 / 0.65
boiler system efficiency. = $14,400 /yr
Total Annual Savings = $27,600 /yr

Investments

The cost of a 15 hp and 30 hp VFD with controls is approximately $8,000 and $12,000 each. The installed cost for the 7 booths is $140,000.

Payback

$140,000/($27,600/yr) = 5.1 yrs.

The resulting simple payback is 5.1 yrs.

PN#3: Replace bag filters with roll filters

Existing Conditions

Some of the paint booths draw exhaust air from the back wall. Bag type filters are used to clean the air. The filters are changed once per week due to the heavy loading of paint particles they remove form the exhaust air. There is a high cost of filters and labor associated with this system.

Solution

Replace the bag filters with a roll media type filter. This type of filter has 2-in. media that is 65 ft long. One paint booth has a filter bank that is 10 filters wide by seven filters high. Since the filters are 20-in. high by 20-in. wide the paint booth is approximately 12 ft high. The rolled ends of the filter will occupy an area of 1½ ft high at the top and bottom of the filter area. Unless the top of the booth is modified to place the top roll out of the air stream the available filter area becomes 3-ft high or 25 percent of the original height. If the top roll is out of the air stream, then 10.5 ft is available for the filter media.

The back wall will need to be moved forward to allow placement of the roll filter drive system that needs to be placed downstream of the filter so it is a clean area.

Savings

It is estimated the current filters cost $20 each so the cost of replacing 70 filters is approximately $1,600 each time. This includes 4 hours of labor at $50 per hour. With these filters being replaced every week the annual cost is $80,000 for a 50 wks/yr.

The roll filter does not have the efficiency as the bag filters and thus will need to be cycled more to remove the paint particles. A 65-ft long roll will provide five cycles of clean media 12-ft high. It is estimated the roll filters would need to be changed every 2 weeks at a cost of $500 for the material and $400 for 8 hours labor. The annual cost to change the roll filters is $22,500.

The annual cost savings is estimated to be $57,500.

Investments

The estimated cost of installing the roll filters is $120,000

Payback

$120,000/($57,500/yr) = 2.1 yrs.

The resulting payback period is 2 years.

Welding Area

In the manufacturing, repair and assembly of electronic-communication components, different welding processes are performed at TYAD. It uses shielded arc, metal inert gas (MIG), tungsten inert gas (TIG), and silver brazing oxygen/acetylene cutting plasma arc methods to complete mission requirements. Major welding jobs are carried out in Building 1A welding area (Figure 12).

Figure 12. Building 1A welding area.

Recommendation for Welding Operation

WD#1: Improve exhaust extraction in Welding Shops in Buildings 1A and 14 and in Motor Pool in Building 15

Existing Conditions

The Welding Shop in Building 1A has a number of welding booths. Smoke eaters from AirFlow Systems Inc. are used to recirculate the extracted air; the air returns to the Welding Shop after passing through filters in the units. There are 8 units, each serving 2 welding booths. According to the shop supervisor, Keith Burns, no more than 10 welders work simultaneously. However, the smoke eaters are not being used, due to:

- Noise
- Bad function of the flexible arms, they are very heavy to maneuver

- The return air is supplied in the back of the units, at high speed, and pieces of cartons were seen at some booths (Figure 13), to prevent the disturbing return airflow
- The sealing of the units, hatches for the filters, are not tight; dust falls down
- The smoke eaters contribute to heating of the space, which is already hot enough.

Figure 13. Carton used in B-1A Welding Shop to protect from air flow and noise

The Welding Shop in Building 14 has a central exhaust system for the welding booths (Figure 14). The system (the exhaust fan) is very noisy. The heat from the welding exhaust is recovered to the supply system (see BH#4). Only 3 welders work in the Welding Shop in Building 14, at maximum. At the assessment visit only one person worked there and the old, noisy system was not in use. A portable welding fume extraction system did not work at the time when tested to start it.

Figure 14. Welding exhaust in Building 14.

The vehicle repair department (Tactical Equipment Repair) in the other part of Building 14 (Figure 15) has a vehicle exhaust system with very stiff flexible hoses, which are not easy to use. There are no dampers on the hoses so the exhaust capacity is not very good since every hose is wide open and the fan sucks air through all hoses.

Figure 15. Exhaust from vehicles in Building 14.

In Building 15, the Motor Pool (DPW Fleet Maintenance Shop), it is very hot and it smells of diesel fumes from vehicles being started inside the building (Figure 16). There is a system for vehicle exhaust with, unfortunately, six very inflexible hoses. They are not easy to use and in most cases not being used. The exhaust fan is too small to do any good and needs to be upgraded.

Figure 16. Exhaust from vehicles in motor pool, Building 15.

Solution

For Building 1A the Smoke Eater filter units, although noisy and require periodic removal of the captured dust, it is felt they may still be used. Improvements can be made by replacing the existing extraction arms, raising and rotating the filters 180 degrees so that instead of blowing cleaned air against the outside wall, air is returned into the centre of the work space. A deflector can be added to direct the returned air upwards toward the roof. New 6-in. extraction arms mounted on new floor columns can be installed. Each could be equipped with an automatic start/stop fan controller that would start the fan upon a welder striking an arc then shut down after welding ends (control box includes a variable time delay for fan over run). The new extraction arms can be either telescopic or elbow jointed (3-7 ft reach or elbow jointed 7 or 10 ft reach depending on what type or length best serves the work load). By rotating the filter around, it would relocate the access doors out of the booths and make it easier to service when needed. By raising the mounting height it would yield some additional booth work height as well as move the noise of the fan discharge upward. Replacement of the seals on the filter access doors would reduce or eliminate leakage observed on some of the units.

Another possible solution would be to locate a dust collector outside the building with a new ductwork system to connect all the booths. This system could be sized for 60–70 percent usage and include a demand control ventilation (DCV) controller to vary the airflow as needed based on user need. The filtered air could be discharged outside or returned through a HEPA filter and a return duct system. This is a rather complicated system as the Welding Shop is basically in the centre of the building. (The dust collector could be placed inside the building, in a room by itself and connected to the Welding Shop via the ductwork system. The filtered air could then be returned back into the shop or discharged to the outside as the weather and temperature dictates).

Welding Shop in Building 14

Due to the low worker occupancy in this facility it would probably be advantageous to remove the existing ductwork exhaust system in its entirety. As described before, it is too noisy and the ductwork is way to large in diameter to have a good dust carrying velocity. The existing heat exchanger appears to be in poor condition. It has become a dust trap and lost its function.

Since there are only three welders in this shop and they have three portable filters, this may be all they need. Portions of the existing exhaust system maybe salvaged and reworked at a minimal expense, but further study is needed prior to a final decision.

Motor Pool/Tactical Equipment Repair Shop in Building 14

This shop is at the rear of the Welding Shop. There is a simple hose drop system with sheet metal cone nozzles and a rope/pulley hose lifting system. This system uses a wall mounted fan on/off switch for control. Most hoses are just hanging down to the floor since the operators do not take the extra time needed to pull the hoses up with the cable located at the outside walls.

It is recommended to replace the system with eight spring recoil hose reels, each with a similar hose, a tailpipe adapter that includes a damper and a fan motor starter system to start the fan whenever a hose is pulled down for use. This change would improve the workers productivity and increase the usage as the fan would start automatically (No one would need to walk across the shop to start/stop the fan when needed). A Demand Control Ventilation fan controller could be added so that the fan does not run at full speed unless it becomes necessary. This would lower electrical cost as well as heat loss.

DPW Fleet Maintenance Shop in Building 15

This shop has an existing exhaust system. It is an old system with metal flex hoses. It is recommended to replace all of the hoses and install a bigger rooftop fan with a better fan starter system. The existing ductwork is in fair condition. There are some leaks and damaged duct sections that need attention, but overall, it can probably be reused.

Possible upgrades involve installing six to eight hose reels in defined work areas/stalls and some retractable hose drops elsewhere (or a rail system where defined work areas do not exist).

This shop serves various equipment from a lawn mower up to wheeled cranes and heavy earth moving equipment, so 6-in. hoses will be required as well as some simple extension hoses in smaller diameters for use on cars and small equipment.

The proposed solutions in the Building 1A Welding Shop should be implemented at the same time as improvements are done regarding the general ventilation (see WD#2 below).

Savings

The savings in energy will not be significant. The savings by implementing the proposed solution comes from:

- Improved indoor air quality (IAQ)
- Reduced space temperature
- Lower maintenance costs
- Welders that use the new flexible arms will be better off, not having to inhale smoke and fume from the welding operation.

Investments

Welding Shop Building1A:	$46,000	
Welding Shop Building 14:	$15,500	including removal of existing system
Tactical Equipment Repair, Building 14:	$30,100	
DPW Fleet Maintenance Shop, Building15:	$38,300	
Total:	$129,900	

Payback

Immediate with respect to improved IAQ, workers' health and productivity.

WD#2: Improve Ventilation in Welding Shop, Building 1A

Existing Conditions

The general ventilation system in the Welding Shop in Building 1A is not working properly. Air supplied into the building hardly reaches the occupancy zone where the welders work. This is because the supply air system is high up at one wall (Figure 17), and no air distribution system and no diffusers in close proximity to the working area. Air is exhausted through 3 exhaust fans at ceiling level. This arrangement is flawed in the supply side of the ventilation system. The design of the supply air system is such that the air supply goes up to the ceiling. Supply air temperature is too high.

Figure 17. Welding supply air system in Building 1A.

Solution

Starting from existing supply air system, install new ducts aiming at the working area, across the space. Connect ductwork and install ventilation ducts to displacement diffusers inside the booths or to horizontal Activent ducts right above the booths. This will make sure that the fresh air from the air handling unit (AHU) really reaches the area where people work. The supply air temperature should be 3 – 5 °F below space temperature, if possible due to limitations of cooling in AHU. If necessary, increase fan speed by changing sheaves.

Savings

Energy savings come from reduced supply air temperature and reduced space temperature during heating season. The energy used for heating the supply air to the Welding Shop is not measured separately and we have no data on the AHU so the calculations regarding savings cannot be done now.

Investments

$20,000 – $30,000

Payback

The payback period is yet to be determined; it was not possible to calculate at this stage.

Building Envelope

It is generally true that implementing building envelope energy conservation measures do not result in quick payback for the investment, but if building is better sealed and insulated, the energy bill will be reduced.

Recommendations for Building Envelope

BE#1: Install Vestibules in IOF To Reduce Heating/Cooling Loads

Existing Conditions

There are several locations in IOF where doors open frequently for transportation of people and goods in and out of the buildings. Examples of such locations are the entrance between Plating and Sand-blasting and the entrance to 1A (Figures 18 and 19). The pressure balance of the buildings is not good. Most of the time, the space inside those large doors/entrances suffer from a very large negative pressure. This results in a very strong, cold, inbound air stream in the winter and a very strong hot air stream in the summer. Both cases are bad for the energy bill as well as for people working inside the building. Cold or hot air stream can travel several hundred feet and sometimes through Building 1A.

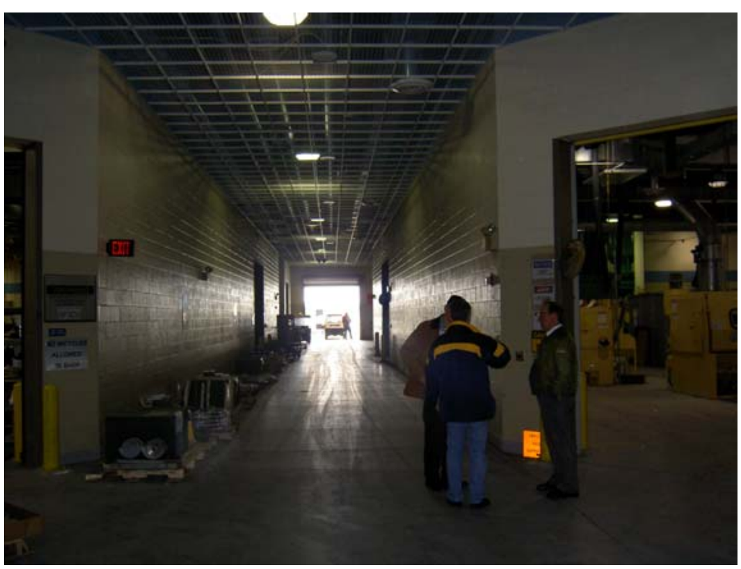


Figure 18. Perfect for airlock, between plating and SB.

Figure 19. Air lock possibility.

Solution

In PL#1, the first recommendation for Plating Shop, certain measures were proposed to balance the supply air with the exhaust air so that the building pressure would be just slightly negative. The expectations were that this would eliminate the needs to install second doors and/or add some walls to create vestibules to prevent the cold or hot air stream coming in. If the pressure control measures were not sufficient, then the following steps shall be taken:

- Add parts of walls so that the area inside the door is closed. In the picture above this means that the left wall must be expanded up to the ceiling (Figure 18).
- Install second, interior door.
- Block the use of both doors simultaneously. Only allow one door open at one.
- Vestibules may be without heat if appropriate.

- For the entrance between plating and sand-blasting no extra wall construction is needed, just the second fast door and the door controls.

Savings

Improvements in thermal comfort and working conditions for people are certain. Energy savings will be in the same range as installing fast doors if there are only old and slow doors now. An example from Rock Island Arsenal energy assessment showed payback time of approximately 3 years for fast doors replacing slow doors. The savings also depend on the magnitude of the negative pressure. It is important trying to balance building pressure first before thinking about installing vestibules.

Investments

Investments may be calculated if there is still a need after controlling air pressure in buildings with respect to Outdoor air pressure.

Payback

To be determined.

BE#2: Use White Roofs

Existing Conditions

A number of the buildings at TYAD are scheduled for a new roof. Currently many roofs at the Depot are dark in color. This dark color will adsorb the sun's energy making the roof hotter than the outdoor air temperature. If a white roof were used, much of the sun's energy will be reflected keeping the roof cooler.

There is 1.9 million sq ft of roof area at TYAD. It is estimated that one million sq ft will be replaced in the next 10 years. It is also estimated that 10 percent of this area is air conditioned.

Solution

Whenever replacing a building's roof provide an outer surface that is painted white or another light color. This will reflect the solar energy resulting in a cooler roof temperature.

Savings

There is approximately 100,000 sq ft of roof area over air conditioned spaces. For areas that are air conditioned this will reduce the annual energy use by approximately 122 kWh per 1000 sq ft of roof area.

Energy savings = 100,000 SF x 122 kWh/ 1000 SF = 122,000 kWh/yr
Energy Cost savings = 122,000 kWh/yr x $0.056/kWh =$6,800/yr

There is no cost savings in buildings with no air conditioning, but the white roof will make them cooler in the summer.

Investments

Changing the roof color when the roof is replaced has no additional cost.

Payback

Immediate

Building HVAC Systems

Select Energy Services Inc. (SESI) is responsible for the operation of most of the HVAC systems and in many cases these are computer supervised and scheduled.

Recommendations for the Building HVAC Systems Operation

BH#1: Reduce heating in warehouses, Buildings 2,5,6,7 and 8

Existing Conditions

The large warehouses, Buildings 2, 5, 6, 7 and 8, are large consumers of natural gas. Warehouse use is not very high. Normally some bays are more or less empty. Only one or a few people work in every warehouse. The space is heated by natural gas-fired Air Rotating Units, RTU, from Johnson Air, maximum 1800 MBtuh. There is one unit per bay, a total of 6 units per warehouse. The temperature setpoint is 68 °F during working hours, i.e., Mon – Fri 5 am to 4:30 pm and sat 6 am to 4:30 pm (which might not actually be working hours). During unoccupied time the setpoint for space temperature is 50 °F. Every warehouse is divided into 6 bays, 200 x 200 ft per bay. The total heated area then is 5 x 6 x 200 x 200 cu ft = 1.2 Million cu ft. Also, there are holes through walls at some of the warehouses.

Solution

Construct a small, combined “office” and break area, for the staff in every warehouse, located where the work station is right now, in the centre of each warehouse. Keep this office heated to 68 °F, at all times, for the well-being of the employees. Reduce space temperature in the warehouses to 45 °F, 24 hrs/day, 7 days per week. If possible, organize the use of the warehouses so that some bays can be closed and not heated at all, until they are needed again. There is a lot of space available to reduce the used size of the warehouse to two thirds of the total space. Fix the holes in the walls.

Savings

Using the data sheet provided by Mr. Jim Brandle on monthly use of natural gas, the total amount of natural gas used during FY04 for warehouses 2,5,6,7 and 8 was in the order of 47,000 Mcf (1,000 cu ft). With a unit price of $6.9/Mcf the annual cost then was $324,000 to heat the warehouses ($0.27/cu ft or roughly $3/m^2 which sounds reasonable).

The average outdoor temperature in the Tobyhanna region during the heating season is 38.4 °F (this includes September although the natural gas consumption data sheet does not show any gas consumption for the warehouses in September; however, including September helps us to keep the calculated savings on the conservative, “safe” side). With the present setpoints for space temperature as described above the average space temperature is slightly above 57 °F. By reducing the space temperature to 45 °F this means that the ΔT for heating is reduced from 18.6 °F to 6.6 °F or a reduction by 65 percent. The annual natural gas savings will then also be 65 percent while everything else unchanged. Heating of the proposed “office” will take some extra gas but that will be covered by the conservative estimate as just stated. Sixty-five percent savings are worth $210,000/yr.

Investments

Five new “offices” with separate small gas-fired heaters will cost no more than $100,000.

Payback

$100,000/($210,000/yr) = 0.5 yrs

BH#2: Improve Radiant Heater Controls in Building 15, Vehicle Washing

Existing Conditions

In the vehicle washing part of Building 15 heat is provided by gas-fired radiant heaters. There are two heating systems, one at each side, just below ceiling level. At one end of the system there is a gas burner, the gas is transported through a tube, radiating heat along its way through the tube (Figure 20). The cooled exhaust gases are then blown out to the atmosphere. There are two thermostats, one for each system. The thermostat settings are at 72 °F, *which is too high*. The thermostats are placed on the inner wall next to each other. Temperature measurements were taken in the washing room. The measured temperatures (24 February 2005) were:

Floor: 79 °F

Ceiling: 88 °F

Walls: 77 °F

This indicates that there is something wrong with the controls of the gas-fired heating systems.

Figure 20. Building 15 vehicle washing room.

Solution

Replace thermostats with an intelligent control system that can better control the gas burners, and both systems coordinated, vs. the wanted space temperature. Lower the temperature setpoint 68 °F. The control system shall also take into account the fact that there is a time span from the burners turned off until the radiators cooled down (thus releasing more heat to the space) and until the heat collected in walls and floor has been released to the air volume in the washing room. Calibrate and fine-tune controls for optimal performance.

Savings

During the period October 2003 to September 2004 the total gas consumption in Building 15 was 3,403 Mcf (1,000 cu ft) at a cost of $23,480, with a unit cost of natural gas of $6.9/Mcf. Our rough estimate is, with respect to the other systems in Building 15, that the gas burners in the washing area use at least 30 percent of the gas used in Building 15. Improved controls and reduced space temperature will save at least 30 percent of that amount, worth $23,480 x 0.3 x 0.3 = $2,100/yr.

Investments

A standalone digital control unit for this type of application will cost about $1,500. Installation, calibration and fine-tuning will cost another $2,000. Total investments are $3,500.

Payback

$3500/($2100/yr) = 1.7 yrs

BH#3: Improve Controls of Heating and Ventilation in Building 10

Existing Conditions

Inside Building 10, there are three major activities: wood working in 10A, boxes and cartons in 10B and generators and trailer repair in 10C. Building 10C also has a separate storage space. Building 10 is heated via the main heating system. Working hours are normally in daytime and occasionally there is a second shift. The following situations were observed on 22 February 2005:

> Wood working, 10A: From wood working machines the exhaust air is taken through a bag filter outside the building, blown back through a ventilation duct into the building and heated, if necessary, by a heating coil. Controls are in bad conditions for this heating/ventilation system. Thermostat setpoint for space temperature for unit heaters was at 66 °F. The actual temperature in this area was much higher, around 74 °F. Mr. George Randall mentioned that the wood working area got very cold during the colder winter days.

Boxes and cartons, 10B: Only one person working in the area. Thermostat setting: 78 °F.

Generators and trailers repair, 10C: There is a paint booth in this part of Building 10. It is generally not used. The temperature in 10C was high, which could be noticed as the door in the west wall was open at bottom (Figure 21). The generator repair part of 10C has a ventilation unit that works only on return air. Air is heated to over 110 °F and the hot air is used to melt snow from vehicles/trailers with generators just taken in from the yard. The hot air stream is not directed towards the trailers, it just blows the air up at a higher level, thus increasing overall space temperature.

The storage area in 10C is almost empty. There are 3 unit heaters to provide heat to this space. The heater setpoints are at 74, 74, and 77 °F, respectively.

Figure 21. Building 10 Box Shop, open door.

Solution

Install four temperature sensors in Building 10. There should be one for wood working, one for boxes and cartons, one for generator repair and one for the storage area of 10C. Retune existing controls or install new controlling device for space temperature control in each of those four areas. All ventilating units and unit heaters in the respective areas should work towards the same temperature sensor. Reduce all setpoints to 68 °F to achieve uniform temperature in all of Building 10. The snow melting ventilation unit should be modified with respect to ductwork: Aim diffusers down towards the objects that have snow on them, but most important: Remove as much snow as possible mechanically (by shovels and brushes) before the generators/trailers are brought in.

Option

Connect the new controllers to the large doors so that all heating units are switched off whenever a door is open in that area.

Savings

There is no separate metering of heat to Building 10. However, using a heating cost of at least $0.5/cu ft, with the high space temperatures and the snow melting device in operation, the total heating costs for Building 10 are estimated to be in the range of $40,000/yr. New and improved controls, in combination with more mechanical snow removal and reduced space temperature (68 °F instead of an estimated average temperature of 76 °F) will reduce the annual heating costs by more than 20 percent. The annual savings then amount to more than $8,000. Working conditions will also be improved by getting a uniform temperature distribution at a lower level. This will increase productivity as well.

Investments

New temperature sensors, four new digital controllers and wiring will cost about $20,000.

Payback

$20,000/($8,000/yr) = 2.5 yrs.

BH#4: Improve Temperature Control and Heating and Ventilation in Building 14

Existing Conditions

The welding area in Building 14 has a rather poor functioning exhaust system for welding fumes. Special solutions for that system is dealt with in ECM WD#1. Also, there is a ventilation system, very old, that has a heat recovery coil in the welding exhaust duct (with virtually no flow in the exhaust system, the heat recovered will be close to nothing). The recovered heat is pumped through pipes to a pre-heating coil in the supply system. After that there is a normal heating coil. One comment was heard from the people working there that "there is no way to control heat in this building." We could verify this since it was hot inside and the welder working there had the door open (Figure 22). Also windows were in open position, just to get rid of the heat. The heat in Building 14 is provided from a small gas boiler that is placed in a separate boiler building just outside Building 14. In the other part of Building 14, there is a Vehicle Repair Shop. Here we found an exhaust system for fumes from the vehicle engines, also in bad shape. In this part of the building heat is provided from a rotating air unit with hot air blowing out at ceiling level (the same type of unit as in the large warehouses). We measured some temperatures in this part of Building 14 and the results were: Floor 79 °F, space 77 °F and supply air temperature from the gas-fired RTU: 81 °F.

Figure 22. Building 14 Welding Shop with open door.

Solution

Install temperature sensors in Building 14. Retune existing controls or install new controlling device for space temperature control in each of the two areas of building 14. All ventilating units and unit heaters in the respective areas should work towards the same temperature sensor. Regulating valves at the AHU in the Welding Shop of Building 14 should be replaced. Reduce all setpoints to 68 °F to achieve a uniform temperature in all of Building 14. Switch off heating automatically when doors are open. Re-direct hot air supply from the gas-fired RTU towards the floor level so that the heat reaches the occupancy zone instead of heating the ceiling.

Savings

Annual gas use in Building 14 was 2,900 Mcf in FY04. Total gas cost was then very close to $20,000. As in previous cases with similar problems and solutions, the annual savings will be in the magnitude of 20 percent, worth $4,000 annually. Working conditions will be improved by getting a uniform temperature distribution at a lower level. This will increase productivity as well.

Investments

$10,000

Payback

$10,000/($4,000/yr) = 2.5 yrs

BH#5: Install Gas-Fired Direct Radiant Heaters in Building 1 C, Bays 4–6

Existing Conditions

Bays 4, 5 and 6 in Building 1 C are heated by horizontally mounted unit heaters with small fans, trying to blow the heated air down to the occupancy level (Figure 23). The fans are too small to accomplish this task. This was confirmed by temperature measurements showing a temperature of 74 °F at ceiling level and at walls. Space temperature was 68 °F. It was also noticed that the lighting in these bays is very poor, the efficiency of the existing fixtures and fluorescent lamps is low. They are also in the wrong places, considering where work is being done. There are plans to change the use of these bays.

Figure 23. Heater in Building 1C Bay 6.

Solution

Drop ceiling level during re-building project. Install gas-fired radiant heaters at the new, lower ceiling level. Install new fixtures and fluorescent lamps with high efficiency.

Savings

Taking into account that the level of activity today is quite low in these bays, with not much energy supplied from machines and equipment, we conclude that these 3 bays, which are 50 percent of the space of Building 1C, stand for at least 60 percent of Building 1C heating use. There is no separate metering of heat to Building 1C. However, using a heating cost of at least $0.4/cu ft, with 25 percent losses from fuel to heat in 1C (boiler efficiency and distribution losses) the total heating costs for Building 1C are estimated to be in the range of $100,000/yr. Bays 4 – 6 stand for 60 percent or $60,000/yr.

Radiant gas heaters have high efficiency. This fact, together with possibilities to drop space temperature and to get a uniform temperature throughout the height of the bays, will save at least 30 percent of heating energy needed for space heating. 30 percent savings amount to $18,000/yr.

Investments

It is not possible to calculate investment costs at this time. Incremental investment when the bays are renovated.

Payback

To be determined.

BH#6: Reduce Energy Usage in Building 23 by Improving Controls and Installing Cold Air Curtain at Main Door

Existing Conditions

Building 23 is not big but its high energy use is of concern. During our meeting with Mr. Bill Muchal, the following observations were made:

- A total of 10 people work in the building, repairing containers on trailers. Operation is 1 shift, 5 days per week.
- New gas-fired heaters, 4 units placed in different locations, provide space heating. The heat outlet, measured to be around 180 °F, is not connected

to any kind of ductwork to get the heat down to where the people work. The ceiling temperature was measured at 83 °F, showing that most of the heat goes directly up to the ceiling.

- A very big and very slow door is opened a number of times per day to let trailers come in and out (Figure 24). These trailers are also very cold in wintertime.
- An exhaust fan is used to exhaust diesel fumes from the trailer towing truck. This fan is operated manually and it sucks warm, polluted air out through a hole in the west wall (Figure 25). There is no supply ventilation.
- The floor space is approximately 50 x 100 ft.
- Thermostat settings for the gas heaters are uniform, all set at 70 °F, but they are in occupancy height and we know in which direction the heat goes.
- Insulation for walls or roof is close to nothing.
- Two air compressors, 20 hp and 10 hp respectively, are placed in a shed outside the building. There was a leak off the air receiver.

Figure 24. Bldg 23, large slow open door.

Figure 25. Bldg 23, exhaust fan to remove diesel fumes.

Solution

Install a cold air curtain for the big door, to keep the cold outside air from coming in to the heated space. Install ductwork and mixing diffusers so that the heat from the heaters can be blown down to where people work. By blowing warm air down the working conditions can be improved. The supply air temperature should be reduced, from 180 to maybe a maximum of 100 °F, otherwise it will not be comfortable to stand close to the diffusers. The warm air will also reach the height where the thermostats are, thus switching off the heaters much more frequently than today. In addition to this: Make an investment in a filter for the towing track diesel exhaust (Figure 26 shows the L20 Exhaust Filter and related technical data). This eliminates the need of the fan in the hole in the wall to get rid of diesel fumes. The fan will then stop exhausting hot air, thus saving more energy and $$. Fix the leak in the compressed air receiver to save energy and compressor motors maintenance and replacement costs.

Savings

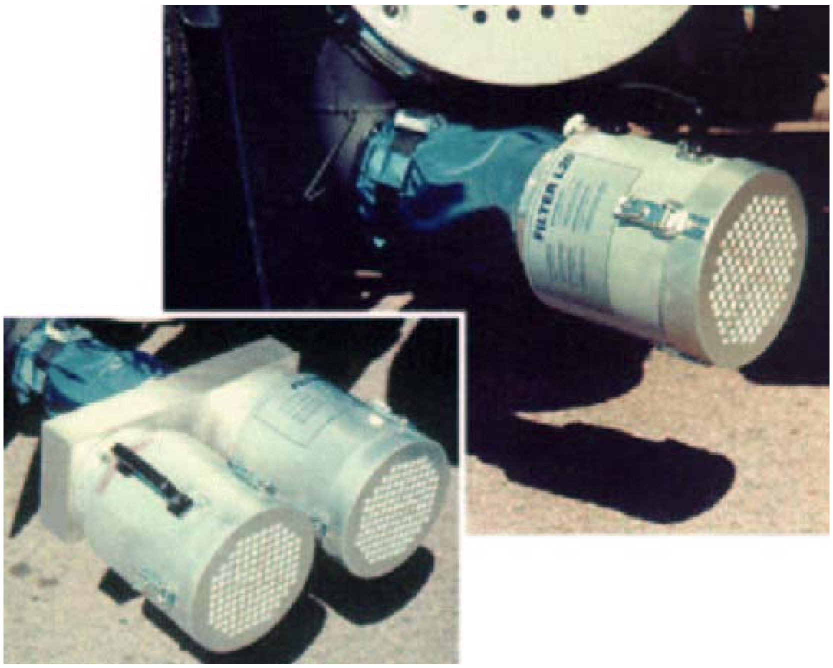
Energy use for Building 23 is not available. It can, however, be concluded that the energy use is substantial and that, under present situation, the heating costs for this building must be high. The suggested solutions will save energy costs in such a magnitude that the payback time will be less than 2 yrs, according to previous experiences, but the major contribution will be in IAQ and working conditions, fewer sick-days, etc.

Investments

To be calculated.

Payback

The payback is yet to be calculated, but is expected to be less than 2 yrs.



For driving inside buildings reduces in room:

Particle separation	over 99.9%
CO separation	~ 30%
NOx separation	~ 60%
RC HO separation	~ 90%
HC separation	~ 35%
Max. engine. L20	16.0L
Max eng. L20 double	35.0L
Max. rpm	1200 rpm
Max. const. temp	200 °C
Max. temp 30 sec.	300 °C
Starts, dies., L20 12.0 l	over 50
Weight:	
L20	5.0kg
L20 double	11.0kg

L20 meet TRGS 554 and COSHH regulation.

The filter cartridge is disposable in normal industry waste.
Data on Exhaust filter for driving inside buildings, for large vehicles.

Figure 26. L20 exhaust filter technical data.

Filters are available through URLS:

www.ehcteknik.com/frames.html

www.sourcetecindustries.com/main/automotive

These products are widely used in the automotive industry.

BH#7: Optimize AHU Running Time and Temperature Settings Depot Wide

Existing Conditions

Many building air handling units (AHUs) are presently run 24/7 despite whether the building is occupied or not. In some units there is a temperature setback during non-occupied hours but the AHU is still running. Since many of these AHUs are very old and their controls, regulating valves etc. are in poor condition, this means that a lot of energy for heating as well as for running motors is used for no purpose. Inefficient energy use was observed from the fact that the space temperature in many buildings or parts of buildings is too high (verified by temperature measurements), combined with how the AHUs are controlled. (High supply air temperatures implies poor ventilation efficiency since the supply air reaches the ceiling level very soon.)

Solution

Use the functionality of the existing Energy Management System (EMS) to optimize control, temperature regulation and supply air temperature as well as running time for those AHUs that are connected to the EMS (40 out of 70 – 80 AHUs connected now). For all other units: Replace old, non-functioning timers and re-program control systems and regulators for more efficient operation. We are aware of the need to replace many of the old AHUs but this cannot serve as an excuse to not working with the old junk as long as it is still there. If there is nothing to re-program: Adjust and change setpoints of whatever can be changed to save energy costs.

One strong recommendation is also to expand the EMS to be depot-wide. This will help continuous improvement and on-line energy systems optimization. BUT: Then there must be much more information taken into the EMS; during the visit it was down for some days and when it worked it was not very useful (Curt Björk's opinion).

Savings

These kind of low cost solutions normally have a payback time of only a few months. Since this was only a Phase 1 assessment, we have not had a chance to get into details for AHUs. Further details on savings will be investigated, measured and calculated in Phase 2.

Investments

Investments will be determined in Phase 2.

Payback

The payback period is yet to be determined, but is expected to be less than 0.5 yrs

BH#8: Stop Heating Building 96

Existing Conditions

Building 96 is used as a storage facility for DPW. It is rarely used, only occasionally does someone go there to get some stuff. The building is not big but it is not insulated either, at least not much. Despite these facts the building is heated, by running a separate boiler, operated on fuel oil (Figure 27).

Figure 27. Building 96.

Solution

Designate Building 96 as a cold storage building for the rest of its lifetime and shut down the boiler.

Savings

No data available on oil consumption but the oil bill for this poorly insulated, leaky building (no snow on the roof while other better insulated buildings had during the assessment) could be several thousand dollars.

Investments

No capital cost, only few man-hours to decommission the boiler.

Payback

Immediate.

BH#9: Stop AHU Heat Flow in Summertime

Existing Conditions

Due to time constraint, detailed studies of heating system controls could not be done in Phase 1. Some processes need heat all year around while others, like AHUs, do not need heat in summertime. The operation of the air handlers is also such that the steam valve opens completely when the outdoor air (OA) temperature is below 35 °F and it closes gradually as OA temperature rises. Nevertheless, if the circulation pumps in the heating system are not switched off during the season when no heating is needed there will be substantial losses, causing unnecessary energy use, in leaking steam valves, maybe in some cases there are also 3-way valves, as well as distribution losses in the huge pipe system.

Solution

For those steam distribution systems that serve only “heating loads”: Program control units to turn off the pumps during periods when the outdoor air temperature is above 61 °F. Then the pumps will normally be off between middle of May to end of September, saving lots of heating energy as well as electricity to run the pumps. For newer control units with auto turnoff capabilities: Program the control units to run the pumps for 30 minutes per week.

Savings

It is necessary to look closer into the summer loads in the heating system to calculate the savings.

Investments

Normally only programming time but if the controls are old then investments will be needed to get this functionality.

Payback

Expected to be within one summer month even with investing in new controllers.

BH#10: Reduce Outdoor Air Flows in AHUs, in Winter and Summer Modes

Existing Conditions

Many AHUs deal with a mixture of outdoor air (OA) and return air. This is a way of reducing the energy use for heating the supply air. Large amounts of OA may cause severe problems in wintertime since the air inside the buildings get very dry. In the summer, when the OA is cooled to get a decent temperature inside the buildings it is much more costly to cool down hot and humid OA than to work with a minimum amount of OA and thus just cool off the internally generated heat that leaves with the exhaust air, which in this case is the same as the return air. If there is a demand for de-humidifying the air this gets even more important. Today, AHUs with air conditioning at Tobyhanna Army Depot has a minimum of 25 percent OA when the outdoor air temperature rises above 75 °F.

Solution

Reduce OA ratio to 15 percent as required by code in summertime, when OA temperature is above 75 °F. In wintertime, when OA temperature is below 23 °F, the OA ratio should also be down to 15 percent. The savings will be tremendous, with respect to:

- reduced natural gas consumption for heating OA.
- reduced capacity needs (tons) for chillers, which also is of great importance when designing the new chiller plant
- reduced electric energy use to run chillers.

Savings

Will be calculated per AHU in Phase 2. Additional savings come from a better IAQ, with higher relative humidity in the winter and drier air in the summer. This enhances productivity and morale of the work force.

Investments

Normally only programming time but if the controls are old then investments will be needed to get this functionality. See also suggested improvements, BH#7, for old AHUs.

Payback

To be determined.

BH#11: Shut Down Boiler, Install Radiant Heater and Fast Door in Bldg. 55

Existing Conditions

Building 55 is occupied by an external tenant (DLA). The heating of Building 55 and Building 9 is provided via a separate boiler, generating 55 psig steam and distributing it to heaters within the building. The building is very big but only about 10 people working there. The space temperature was measured to be 68 °F. Goods is loaded and unloaded through a very big door. At the time of visit, the door was wide open and a truck was parked half way in. Loading was done on the inside. According to Mr. John Billack, this door is practically always open, even in wintertime. The tenant pays for its own energy bill. However, it is not clear whether they pay for all of the heat or only a fixed sum per month or year. Despite who is paying the bill, Government (DLA and/or TYAD) is spending a substantial amount of money to heat Building 55, which is of concern. In addition, the use of the building is quite low; there is a lot of empty space in the building.

Solution

There seems to be lots of savings to be achieved by:

1. Shutting down steam boiler and steam distribution system
2. Installing direct, gas-fired radiant heaters, burning gas as needed without large losses
3. Heating only areas where people work, in the area to the right after entering through the door (towards Building 9)
4. Installing automatic fast door, which closes as soon as there is no traffic through the door.

Savings

In FY04 the natural gas used for Building 55 (all for heating) was close to 30,000 Mcf, at a cost of $207,000. Quite a lot natural gas was also used in summer; it is not clear whether they have processes in there that require natural gas all year around or if the summer use is to keep the boiler and the steam distribution system warm, up and running without any heating needs. The floor area is approximately 180,000 cu ft, which gives a specific cost of natural gas for Bldg 55 of $1.15/cu ft, which is extremely high. Suggested solutions will be able to reduce that number by 50 percent, giving an annual saving of $100,000.

Investments

Investments are yet to be calculated, but experience says that this could be done for less than $100,000.

Payback

Payback will occur in 1 year if all natural gas used in Building 55 is for heating purposes. Since this is a tenant occupied building, we did not spend much time in there. That is why the data is a little uncertain.

BH#12: Renovate AHU in Building 18, DPW Office

Existing Conditions

In Building 18, the DPW office, there was something wrong with the air handling unit. The space temperature was measured to be around 77 °F, which might be too warm. The AHU does not work properly with such high indoor temperature. It could also be heard, although we were not able to get up to the AHU, that the unit cycling on and off too frequently. It starts, runs for a couple of minutes, shuts off and then starts within minutes again. This is not good for the fan motor.

Solution

Check the AHU functions and replace malfunctioning control units and regulators. Run the unit continuously during working hours, shut off during unoccupied time. Reduce space temperature to 68 – 70 °F. This will enhance productivity.

Savings

Not possible to calculate with any accuracy. We have no data on the specific AHU. Calculation of savings could be done in Phase 2.

Investments

Required investments will depend on the condition of the AHU.

Payback

Payback is expected to occur within 1 year.

BH#13: Use a Dedicated Ventilation Air Distribution System for Building 11 Air Conditioning Project

Existing Conditions

The major administrative building at Tobyhanna Army Depot is the Headquarters Building, which is also identified as Building 11. It is a two and three story structure having an area of approximately 185,000 sq ft. The air conditioning of this building is through the use of window air conditioners and other small local systems. This project is to provide new central type air conditioning equipment for the building's heating, ventilating, and cooling system. The system being proposed is a variable volume system (VAV). This system uses central air handling units to provide a variable flow of cool air to all building spaces. The quantity of air depends on the cooling demand of the space. Hence more air is provided if more cooling of the space is wanted.

The installation of this system will require removal of all the ceiling tiles to provide access to the space above the ceiling. Other services above the ceiling may need to be relocated to make room for the duct system that moves the air from the AHU to the rooms being serviced. Cooling will be accomplished by local refrigerant equipment.

Solution

Consider the use of a dedicated ventilation air distribution system; this system will handle all the ventilation air requirements of the building. The space heating and cooling needs will be the responsibility of another system. Either a radiant heating and cooling or a fan coil type system can be used. Rather than using air to heat and cool spaces a fluid such as water can used. This reduces the size of the distribution systems and they can be more readily installed in the existing ceiling space. Radiant cooling and heating panels, or fan coil units in the ceiling space, can be used for space temperature control.

The outside air unit can use evaporative and heat recovery technologies. The evaporative cooling unit reduces the air temperature while it increases the air humidity levels. An indirect evaporative cooling unit can be used to avoid the humidity gain. This unit uses a heat exchanger to reduce the supply air temperature. An air stream is cooled by using an evaporative cooler. This cooled air enters an air-to-air heat exchanger and the lower evaporative cool air is used to absorb the temperature of the supply air thereby lowering its temperature.

Savings

The savings will result from a reduced first cost of the building's air conditioning system. The system will also provide improved performance with better ventilation and temperature control.

Investments

The installed cost of the proposed system will be lower than the initial system.

Payback

The payback is quicker than that of the initial system due to the lower first cost.

Recommendations for the Chiller Plant Projects

CP#1: Use Thermal Storage Tank for Chiller Plant

Existing Conditions

At the Tobyhanna Army Depot Industrial Area, a number of air cooled refrigeration machines are used for cooling in the supply air system. These units are nearing the end of their useful life and there is more efficient equipment for replacement. In Building 1A there is a chilled water system having a cooling capacity of 250 tons that can also be upgraded.

The existing refrigeration equipment requires a large amount of maintenance to keep it operational. Some of the areas served by the air conditioning system require a specified temperature or the process equipment will not perform correctly. Some of the industrial areas repair electronics and controlling the space temperature is required for quality parts.

To reduce the maintenance costs of this equipment as well as increase the energy efficiency, a central chilled water system will be constructed in the Industrial area. It is proposed to initially provide three 500 ton chillers that are cooled by cooling towers. These chillers will be piped to all air handling units that provide cooling. If the cooling is by direct expansion units, a chilled water coil will need to be installed in the air handler unit. In some cases, it will be more cost effectively to replace the air handling unit rather than replacing the cooling coil and making other necessary modifications.

Solution

Construct a central chilled water system that uses thermal storage to offset part of the total cooling load. The system will run its chillers a greater percent of the time, placing the excess chilled water into the storage tank. When the chillers can no longer meet the cooling load demand, chilled water is withdrawn from the storage tank to make up the difference.

It is estimated that a 350,000-gal tank is required to store this water. A tank of this size will offset the installation of one 500 ton chiller system including its cooling tower, pumps and chiller. The thermal storage tank is estimated to be approximately 40 ft high and 38 ft in diameter. A place near the chiller building will need to be identified for locating the thermal storage tank.

Savings

Savings provided by a thermal storage tank are created by generating chilled water during periods of low electrical demand and being able to operate chillers at peak efficiency during periods having low cooling loads. Since TYAD pays electrical demand charges, there may be some cost savings associated with this. There are spaces at TYAD that require year-round cooling and the chiller would need to operate when the air side economizer cannot satisfy the cooling load. It is estimated this load is present during the non cooling seasons for 600 hours per year. It is also estimated the chiller at this load operates at 80 percent of the efficiency of peak load. The estimated average load during this time is 30 percent of the chiller capacity or 100 tons.

Electrical energy saved = 100 tons x 0.6 Watts/ton x 0.3 x 600 hrs/yr = 10,800 kWh/yr
Electrical energy cost savings = 10,800 kWh/yr x $0.056/kWh = $605/yr.

Investments

The cost of a 350,000-gal insulated thermal storage tank is $350,000. Add $100,000 for piping, valves and controls. Total cost is $450,000. The tank will replace the need for a 500 ton chiller, cooling tower and associated piping, pumps and controls whose cost would be $550,000. There is a net savings of approximately $100,000.

Payback

Immediate

Evaluation of the Operation of the Building 1E Shot Blast Media Collectors

SB#1: Consider Decentralizing Shot Blast Media Collection To Reduce Energy Consumption (this recommendation is dropped due to safety concern)

Existing Conditions

The media blast processes for metal cleaning consist of eight medium and two small glove blast units. A central exhaust runs 500–1000 ft to a bag house with a 75hp exhaust fan motor. Typically 2 -3 of the blast units are being used at any one time but the central exhaust runs 24 hr x 5 day (6,000 hrs/yr).

Solution

Consideration was given to de-centralizing the 10 metal cleaning units by providing each unit with its own, local media blast collection system consisting of a small dedicated exhaust fan and HEPA filter system. The exhaust fan will operate only when an operator is blasting, saving 80 percent of the existing high energy losses and full shop runtime of the central 75hp system. The “potential” savings calculations are shown below.

Savings

Potential savings = 75hp x (90% loaded/90% efficient) x 0.746kW/hp x 6,000hrs/yr x $0.056/kWh = $18.8k/yr

Investments

Investments calculations not pursued due to safety concerns raised by TYAD personnel.

Estimated Risk Level

The estimated risk level is high (input by TYAD management). This solution was judged by TYAD to be unsafe due to IAQ concerns from the hazardous coatings that are often found on the parts. As a result, this solution is not recommended.

Lighting

Select Energy Services, Inc. is responsible for the lighting service at TYAD.

Recommendation for Lighting

LT#1: Lighting Retrofit

Existing Conditions

The facility recently completed a retrofit of its lighting fixtures. While a majority of the lighting fixtures detailed under the retrofit plan were replaced, a large number were not changed. This was because the retrofit work would have interfered with operations at the time.

Issue

The lighting fixtures and lamps that were not replaced are older units that are not energy efficient. They should be replaced and the lighting retrofit completed.

Solution

Replace the older generation lighting fixtures and lamps with updated fixtures and lamps.

Savings

The vast majority of the fixtures that were not retrofitted are 4-ft fixtures with four lamps, totaling 192W apiece. One hundred of these fixtures, operating 2,000 hrs/yr, consume approximately 39,000 kWh of electricity. Their replacements, 4-ft fixtures with three lamps totaling 84W apiece, consume approximately 17,000 kWh of electricity for the same period of time. The difference is approximately 22,000 kWh of electricity, which, at a rate of $0.056/kWh, costs $1,200/yr. This amount reflects only 100 fixtures; there is reason to believe that there are several if not many such “blocks” of fixtures still waiting to be retrofitted. Even five “blocks” of fixtures represents $6,000 in annual savings, a sizeable number. Also, these savings do not include demand savings as well as a heating penalty and air conditioning savings. Since the contractor has taken over maintenance of the lighting system at the facility, there will be no maintenance savings gained from this recommendation.

Investments

It is unclear whether the government can still have the older fixtures replaced under the old contract at no cost or if it will have to pay a second time to have the fixtures replaced. Considering that the lighting contractor that replaced the lighting is still under contract for maintenance of the new lighting fixtures, it is likely that replacement of the older lighting fixtures can still be accomplished under the original contract at no cost to the government.

Payback

The payback for this recommendation will vary depending on whether the work is covered under the current contract or if a new contract must be negotiated. If the work can be completed under the current contract, the payback will be immediate as there is no cost. If the work is not covered, plant personnel have estimated that retrofitting will cost approximately $300 per fixture.

Boiler Plant

There are three boilers in Building 1B and two in Building 1C.

Recommendation for the Boiler Plant

BP#1: Install Economizers on Boiler Stacks in Buildings 1B and 1C

Existing Conditions

The boilers do not currently recover any heat from the boiler stacks.

Solution

Install an economizer on each of the boilers in Buildings 1B and 1C. The economizers would be installed on the boiler stacks and would preheat the makeup water. The boilers in Building 1B would need to be retrofitted with individual boiler stacks because all three stacks are connected to one stack. The use of economizers would result in an increase in thermal efficiency of the boilers and an overall decrease in operating costs.

Savings

Savings and operating costs were estimated using the Steam System Assessment Tool (SSAT) developed by the U.S. Department of Energy. The SSAT was programmed with input data gathered during the Phase 1 assessment.

The program can be downloaded at the US Does Best Practices website through URL:

www.oit.doe.gov/bestpractices/steam

Although SSAT has no actual calculations to show an economizer installation, a general rule of thumb is that an economizer will increase the efficiency of the boiler by an average of 5 percent. Since SSAT can model boiler efficiency increases, this method was used to simulate an economizer installation. Table 7 lists current and proposed annual natural gas usage and associated annual cost savings of the boiler systems in 1B and 1C.

Table 7. Energy and cost savings.

Location	Current Annual Natural Gas Usage (MMBtu/yr)	Proposed Annual Natural Gas Usage (MMBtu/yr)	Total Annual Energy Savings (MMBtu/yr)	Total Annual Cost Savings ($/yr)
1B	131,400	123,516	7,884	$54,163
1C	36,281	34,237	2,044	$14,042
Total	167,681	157,753	9,928	$68,205

Cost Savings = [(Current Natural Gas Usage) – (Proposed Natural Gas Usage)] × (Natural Gas Cost)

Cost Savings = [167,681 MMBtu/yr – 157,753 MMBtu/yr] × $6.87/MMbtu

Cost Savings = $68,205/yr

Investments

Economizers in Buildings 1B and 1C would cost $10,000 each. A total of five economizers would be used in this recommendation for a total equipment cost of $50,000. Installation costs are estimated at $10,000 per economizer or $50,000 total, which also includes penetration of the roof for all units. Therefore, the total implementation cost is $100,000. More detailed budget numbers will be based on measurements conducted during a Phase 2 assessment.

Payback

$100,000/($68,205/yr) = 1.5 yrs.

BP#2: Use IOF Boiler To Provide Steam for Building 1B, 1C, and IOF

Existing Conditions

Currently two separate boiler systems provide steam to Buildings 1C and 1B, as well as to the IOF. Both of these systems produce 100 psig steam. Three boilers, located in Building 1B, provide process and space heating to Building 1B and the IOF, while two boilers located in Building 1C provide space heating to that building only. In addition to these five boilers, there is a large water tube boiler located in IOF. This boiler is sufficiently sized to support all the steam requirements of Buildings 1B and 1C, as well as the IOF, but it is not used. The IOF boiler is a dual fuel unit that can also use #2 fuel oil instead of natural gas to provide steam. The unit is not fully shut down, but instead is kept in an energized state.

Issue

The IOF boiler has a significant advantage over the five operational boilers in that it can also use #2 fuel oil to create steam. This is significant because the local natural gas utility has offered to reduce the unit price of natural gas if the facility participated in a curtailment program. If the facility used the IOF boiler instead of the five boilers to provide steam, it would be able to participate in the curtailment program offered by the local utility. Currently it cannot participate because the IOF boiler is not kept in a ready state to come online in a short period of time. If the IOF boiler were providing the facility's steam instead of the five boilers, it would be ready in short order to switch over to #2 fuel oil if called for by the natural gas utility. In addition to lowering the unit cost of natural gas for the entire facility, this strategy would also reduce operating and maintenance costs as only one boiler would be functioning instead of five boilers as is the case now.

Another advantage to operating one boiler as opposed to five units is that the other boilers can be used as backups and would not wear out as quickly.

Solution

Use the IOF boiler to provide steam for both Buildings 1B and 1C as well as the IOF itself. The boiler is more than capable of handling the load for the three buildings. This would directly reduce the operating and maintenance costs of the boiler system for these buildings. Additionally, if the facility participated in the curtailment program, natural gas unit costs would be reduced for the entire facility.

Savings

Both the current and the proposed steam systems were modeled using the SSAT. The model revealed that the current boiler systems use a total of 167,681 MMBtu/yr of natural gas, which at a rate of $6.87/MMBtu results in a total annual cost of $1,151,968/yr. Although in most cases operating one boiler as opposed to five would reduce natural gas usage, in this case there is a slight natural gas usage increase. The IOF boiler is a water tube model. According to assessment team calculations, the boiler would be operated at an average load of 43 percent. Operating water tube boilers at low loads causes increased heat loses through the shell. Due to this fact, the IOF boiler would operate with less efficiency than the other five boilers.

According to the SSAT model, the natural gas usage of the IOF system would be 168,441 MMBtu/yr. However, since this boiler would be able to use #2 fuel oil, the facility would be able to participate in the gas utility's curtailment program. Unfortunately, after repeated attempts to reach plant personnel at the facility, the assessment team could not determine what the reduction in the natural gas cost would be or the estimated number of curtailments in which the facility could expect to participate. Considering that the facility had a natural gas budget of $2.1 million in FY04, even a 5 percent decrease in natural gas costs would result in over $100,000 in savings.

The savings for this recommendation will be calculated by the Phase 2 assessment team.

Investments

Since the boiler is already in place, there are no direct costs for switching the operation of the system to this boiler. However, this boiler is only piped into the main header for Building 1B, therefore, additional piping will be necessary to connect this system with 1C. This cost is estimated to be $30,000. Additionally, during periods of heavy snow fall, it is difficult to access the facility's #2 fuel oil storage tanks. To ensure that the tanks are accessible, it is recommended that a cover or barrier be built near or around the oil tanks to ensure that they are accessible by personnel and equipment. This cost is estimated to be $100,000. There will be additional costs incurred to update the steam system, such as repairing seals and steam leaks. This cost is estimated to total $10,000. The total cost of this recommendation is then $140,000. Also, if the IOF boiler must be tended 24/7, then the additional labor cost needs to be considered.

Payback

No payback can be calculated at this time due to the lack of available curtailment information. Assuming a single curtailment results in a 5 percent cost reduction in natural gas pricing, the savings would be approximately $100,000, resulting in a simple payback of less than 2 years.

Evaluated (but not Recommended) Improvement Ideas

Reduce Surge Tank with Deaerator Tank

This facility's boiler system uses a deaerator tank/surge tank combination. The surge tank collects the condensate, which is then fed to the deaerator tank. It was proposed that the surge tank be replaced with a deaerator tank. However, ideal condensate return temperatures for a deaerator would be 212 °F or higher. The condensate of the boiler systems at this facility is lower than 212 °F. Taking this into account, as well as fact that the boiler system already has a deaerator, savings for this recommendation would be relatively low. Furthermore, the high cost of deaerator tank would result in a high payback. Therefore, the facility should not pursue this recommendation.

Reduce Boiler Pressure

It was suggested during the course of the assessment that the boiler pressure could be reduced from 100 psig to 48 psig. Using the SSAT developed by the U.S. Department of Energy, the savings and operating costs of this action were determined. The SSAT was programmed with input data gathered during the Phase 1 assessment. It was found that reducing the boiler pressure would not yield any significant savings. This is due to the boiler output pressure having little effect on its natural gas usage. Greater natural gas savings can be achieved by the installation of backpressure steam turbines. Therefore, the facility should not pursue this recommendation.

Compressed Air Systems

Central Compressed Air System at IOF

According to measurements taken on site, as well as interviews with plant personnel, the central compressed air system at IOF is currently using a base and trim control strategy. There are two base compressors that are supported by a trim compressor that handles increased compressed air demand in excess of the base load. Supporting these three compressors is a fourth unit that acts as a backup in case of failure.

The energy usage of four compressors was calculated based on spot readings taken on-site. The spot readings measured the average loaded power draw of the compressors and are tabulated in Table 8.

Table 8. Compressor energy use and cost.

Compressors	Total Annual Energy Consumption (kwh/yr)	Annual Energy Cost ($/yr)
Base Compressor #1 (IOF)	867,240	48,565
Base Compressor #2 (IOF)	858,480	48,075
Trim Compressor #1 (IOF)	277,196	15,523
Backup Compressor (4-2)	175,200	9,811
Total	2,178,116	121,974

Recommendations for Compressed Air System Operations

CA#1: Use Engineered Compressed Air Nozzles

Existing Conditions

The facility uses standard air nozzles on its compressed air lines. These nozzles are less efficient than engineered nozzles, which use less compressed air while achieving the same results.

Issue

Compressed air is commonly used in manufacturing plants for cleaning, cooling, drying parts, and removing metal chips, but high-pressure air in these blowoff applications often creates problems due to the cost, noise, and potential danger. Compressed air ejected from open lines, copper tubes, and drilled pipes are a few of the common abusers.

But the most important factor to boosting efficiency is proper use. Engineered air nozzles and air jets, for example, cut operating costs by using only a fraction of the compressed air of typical blowoffs using standard nozzles, particularly if they can be cycled on and off so air is used only when needed.

Solution

Using engineered air nozzles, this facility can reduce the amount of air consumed in their compressed air processes. This is because regular air nozzles release excess amounts of air than what is actually needed to do the same task.

Using engineered air nozzles will reduce the amount of energy that is used to compress the volume of lost air from atmospheric pressure to the compressor operating pressure. Engineered nozzles save approximately 30 percent of the compressed air used by a standard nozzle. In addition to the energy savings, the facility will reduce the noise levels in the plant, as well as provide additional safety not found with conventional open pipe operations.

Savings

A 5/16th-in. diameter copper tube blowoff (similar to a standard air nozzle) consumes about 70 standard cu ft per minute (scfm) of compressed air, given a 100-psig plant air supply. The compressed air consumption can be reduced to 12 to 16 scfm by replacing the open tube with an air jet or an engineered nozzle. Generally, a 10-micron filter separator is recommended on the air supply side of the air jet.

Assuming continuous operation and a value of 19kW per 100 cfm, the energy savings due to replacing the copper tube with an air jet are approximately:

Savings = 8,760 hrs/yr x (70 – 16 scfm) x 19 kW/100 scfm = 89,877 kWh/yr

Given an electricity price of $0.056/kWh, the savings from this recommendation are valued at more than $5,000/yr per nozzle. With an installed cost of less than $200 per nozzle, the payback is almost immediate.

When selecting air jets and nozzles, the lowest flow nozzle that will achieve the desired result should be selected. This maximizes air consumption savings while minimizing noise. Some air jets and engineered nozzles have an adjustable airflow feature. Ball joints may be provided with air control nozzles to provide for simple adjustment of the nozzle orientation. The facility should consider installing a pressure regulator upstream of the air nozzles, and increasing the savings realized by regulating pressure down to the absolute minimum necessary to achieve the desired result. In some cases, a dedicated low-pressure blower can be specified to meet application requirements.

CA#2: Compressed Air Leaks Repair

Existing Conditions

Leaks in a compressed air system can use between 20 and 30 percent of a compressor's output.* The problem of chronic air leaks is often addressed by installing excess and unneeded compressor capacity, which results in higher costs. Air leaks also decrease the life of compressors and ancillary equipment by causing frequent cycling and increased running time. Leaks can also cause fluctuations in the system pressure, resulting in less efficient operation of air-powered tools.

The best way to detect leaks is with an ultrasonic leak detector. These units are easy to use but costs and sensitivities vary. A less costly but still effective way to detect leaks is to apply soapy water to the suspected area with a paint-brush.

Compressed air leaks are most common in hoses and at couplings, fittings, quick disconnects, etc. Leakage rates vary depending on the supply pressure and, as illustrated in Table 9, the size of the leak orifice.

Table 9. Air flow leak rates.

Pressure (psig)	Orifice Diameter (in.)					
	1/64	1/32	1/16	1/8	1/4	3/8
70	0.3	1.2	4.8	19.2	76.7	173
80	0.33	1.3	5.4	21.4	85.7	193
90	0.37	1.5	5.9	23.8	94.8	213
100	0.41	1.6	6.5	26.0	104	234
125	0.49	2.0	7.9	31.6	126	284
Note that all values are in cfm.						
for well-rounded orifices, multiply the values by 0.97						
for sharp-edged orifices, multiply the values by 0.61						
Source: Compressed Air Challenge						

Solution

Repair the compressed air leaks in the facility's compressed air distribution system. By repairing these leaks, significant energy savings can be realized.

* http://www.oit.doe.gov/bestpractices/pdfs/compressed_air3.pdf, 27, April 2005

Savings

A conservative leakage percentage of 25 percent of the compressed air supply's energy usage, based on the range provided above, was assumed for this recommendation. Based on continual operation of the compressors, it is estimated the cost savings would be approximately $30,000. This number will be refined during a Phase 2 assessment.

Cost Savings = (Energy usage of Compressed Air System) × (Electricity Cost) × 25%
Cost Savings = 2,178,116 kWh/yr × $0.056/kWh × 25%
Cost Savings = $30,494/yr

Investments

Accurate installed cost budget numbers will be based on measurements conducted during a Phase 2 assessment. However, the magnitude of these costs is expected to be relatively low. Past experience indicates that detection, location and repair of a compressed air leak costs less than $200, which also includes materials.

Payback

Based on previous experience, investments of this type typically have a simple payback of less than 1 year. In fact, repair of compressed air leaks normally pays back in no more than 4 months.

CA#3: Eliminate Inappropriate Compressed Air Usage

Existing Conditions

Compressed air is being used inappropriately at this facility. According to plant management, compressed air is commonly used for personal cooling. Inappropriate uses increase the load on a compressed air system and account for unnecessary noises due to open nozzles. The DOE estimates that inappropriate air use accounts for 5–10 percent of the total energy usage of a compressed air system.* For this recommendation, a conservative 5 percent reduction in total energy usage will be considered.

* OIT, U.S. Department of Energy, http://www.eere.energy.gov/industry/steel/pdfs/compressed_air.pdf

Solution

Eliminate inappropriate compressed air usage throughout the facility, specifically personal cooling of plant personnel using compressed air.

Savings

The energy usage of four compressors was calculated based on spot readings taken on-site. Table 10 lists the spot readings measured the average loaded power draw of the compressors.

Table 10. Compressor power draw analysis.

Compressors	Total Annual Energy Consumption (kwh/yr)	Percent Factor	Total Annual Energy Savings (kwh/yr)	Total Annual Cost Savings ($/yr)
Base Compressor #1 (IOF)	867,240	5%	43,362	$2,428
Base Compressor #2 (IOF)	858,480	5%	42,924	$2,404
Trim Compressor #1 (IOF)	277,196	5%	13,860	$776
Backup Compressor (4-2)	175,200	5%	8,760	$491
Total	2,178,116	--	108,906	$6,099
Note: Compressor motor efficiencies were determined through the use of MotorMaster+.*				

Cost Savings = (Energy of Compressed Air System) × (Electricity Cost) × 5%
Cost Savings = 2,178,116 kWh/yr × $0.056/kWh × 5%
Cost Savings = $6,099/yr

Investment

There is no implementation cost associated with this recommendation.

Payback

Payback will be immediate.

CA#4: Install Zero Loss Air Trap Drain for the IOF Trim Compressor

Existing Conditions

The 60 hp trim compressor in the IOF Building currently purges lubricating oil through the use of a ¼-in. copper pipe and elbow when the compressor is in its unloading stage.

* Washington State University Energy Program, version 4.00, U.S. Department of Energy, MotorMaster+, 2003.

Issue

During the purging process, compressed air is lost along with the lubricating oil at approximately 50 psig, according to the compressor manufacturer.

Solution

To retain the compressed air leaving the compressor, a zero loss drain should be installed. This device will only release lubricating oil when it reaches a maximum level within the trap and will close after the lubricating oil reaches a minimum level. Since it does not use compressed air to release the oil, the zero loss drain reduces the demand spikes of the air compressor, resulting in electrical energy savings. According to an industry vendor, the large amount of oil being purged from the compressor is a strong indicator that there may be a clogged orifice or a problem with the separator within the system. This should also be looked into immediately, so as to not affect the production of the facility. It should also be noted that the installation of a zero loss air trap drain would not affect the performance of the compressor or the production of the facility.

Savings

For the purpose of this report, an accurate savings number needed to be calculated, so the purging process was calculated as a compressed air leak operating on the unload schedule of the compressor, which corresponds to approximately 33 seconds per minute, or 4,730 hours/yr. The savings associated with this recommendation are approximately $2,075/yr.

Total Annual Energy Savings = (horsepower usage of the drain) × (hours of purge) × (Usage factor) × (Conversion constant) × (Electricity cost)
Total Annual Energy Savings = (10.5 hp) × (4,730 h/yr) × (0.746 kW/hp)
Total Annual Energy Savings = 37,050 kWh/yr
Total Annual Cost Savings = 37,050 kWh/yr ($0.056/kWh)
Total Annual Cost Savings = $2,075/yr

Investments

The unit cost of a zero loss air trap drain is approximately $115. There is also an associated labor cost with the installation of the zero loss drain, which could be accurately calculated during a Phase 2 assessment. It should also be noted that additional piping may or may not need to be installed, but costs should be minimal.

Payback

This particular investment is expected to pay back within 2 months.

Evaluated But Not Recommended Ideas

Use Outside Air To Cool the Compressor Room

It was suggested during the course of the assessment that the facility use outside air to cool the air compressors. This was suggested to increase motor life. Research indicates that using outside air to cool the air compressor room at the facility would have little or no effect on motor life.

An electric motor's insulation system separates electrical components from each other, preventing short circuits and thus, winding burnout and failure. Insulation's major enemy is heat, so it is important to ensure that the motor be kept within temperature limits. There is a rule of thumb that says a 50 °F rise in temperature reduces insulation life by half, while a 50 °F decrease doubles insulation life. This implies that if a motor is kept cool enough, the windings will last forever. These rules of thumb ignore factors such as moisture, vibration, chemicals and abrasives in the air that also attack insulation systems.

The real issue is at what temperature the motor windings are designed to operate for a long and predictable insulation life—20,000 hours or more. NEMA, the National Electrical Manufacturers Association, sets temperature standards based on thermal classes, the most common being A, B, F and H. A summary is provided in Table 11.

Table 11. Motor insulation class and thermal rating.

Insulation Class	Maximum Winding Temperature
A	105°C (221 °F)
B*	130°C (266 °F)
F*	155°C (311 °F)
H	180°C (356 °F)
*Most common classes for industrial-duty motors Table shows highest allowable stator winding temperatures for long insulation life. Temperatures are total, starting with a maximum ambient of 40° C (104° F).	

Class B or Class F insulation systems are usually used in today's industrial-duty NEMA "T frame" motors, the type found in most compressed air systems. Many manufacturers also design their motors to operate cooler than their thermal class might allow. For example, a motor might have Class F insulation but a Class B temperature rise. This provides an extra thermal margin of safety. Class H insulation systems are seldom found in general-purpose motors, but rather in special designs for very heavy-duty use, high ambient temperature or high altitudes.

These design ratings for temperature apply to the hottest spot within the motor's windings, not how much of that heat is transferred to the motor's surface. Unless there is detailed knowledge of a specific motor model's design, including benchmark lab readings of heat runs that show "normal" surface temperatures for that specific model in exact locations on the frame, a motor's "skin temperature" provides little if any evidence of what's going on inside.

Because of this, exterior cooling of motors using outside air will have little if any impact on motor life. The heat created by a motor's windings will more than overcome the effect of cool air directed at or residing on the motor's surface. Due to this, using outside air to cool the air compressor motors should not pursued by this facility.

Recommendations for the Building 11 Cafeteria Operations

CF#1: Consolidate Walk-In Cold Food Storage: Shutdown Three of Eight Coolers/Freezers; Repair Door Seals and Use COG Type-V-Belts on Refrigeration, Compressor Motors

Existing Conditions

In Building 11 cafeteria, the food service area has eight small to medium walk-in cold storage/freezer units (Figure 28). Mr. Richard Chermanski, food services manager, suggested to consolidate the cold storage using 5 of the 8 existing units to save energy and reduce maintenance. This is now possible because of the faster order refill from the existing food suppliers. The existing door seals and latches do not close tightly. The current refrigeration motor drives are using inefficient V-belts not COG type V-belts.

Figure 28. Walk-in cold storage freezer units.

Solution

1. Shutdown walk-in units #2, #6 and #8 and store food in the remaining units #1, #3, #4, #5 and #7, which will still provide more than adequate storage capacity.
2. Replace existing, low efficiency V-belts on freezers #3 and #4 compressors with COG type belts and also on the cold storage compressors for units #1, #5 and #7.
3. Repair door seals and latches on the remaining 5 units.

Basis for Economic Calculations: Assumptions and Cost Basis of Savings (CBoS)

1. Cold storage refrigerators have 10hp drives (2 units) w/ standard V-belts that waste 2% of motor load.
2. Freezers have a 15hp and a 30hp motor both running with standard V-belts.
3. Motors are 90% loaded, 85% efficient and run 60% of the time (leak/seals).
4. Maintenance records show $440k/yr on 8 cooler/freezers.
5. Food waste due to maintenance issues is approx $1k/yr.
6. Retiring 3 of 5 coolers saves 60% of operating costs and 30% of maintenance costs.
7. COG belts have 2% vs. 4% power transmission losses on motor drive.

Savings

Existing operating cost (energy + maintenance + food losses)
Walk-in coolers (38 °F) = 10hp x 0.746 kW/hp x (90% loaded/85% efficient) x 60% runtime x 8,760 hours/yr x $0.056/kWh = $2,325/yr
New energy = existing energy ($2,325/yr) x 3 of 5 retired (70%) x 60% run time = $975/yr
Compressor motor savings = $2,325 – $975 = $1,350/yr
COG belt savings
(1) Freezer motors = (15 hp + 30 hp) x 0.746 x (0.90/0.85) x 60% x 8760 x $0.056/kwh = $10,500/yr
(2) Cooler ($2325/yr) + freezer ($10,500/yr) x 2% COG belt savings = $250/yr
Maintenance savings = $40k x (3 of 8 units) = $15k
Food loss savings = $1000/yr now x 50% less = $500/yr
Gross/Savings = C + D + E = $1350 + $250 + $500 = $1600/yr
Cost estimate = No capital investment, minor seal and belt expenses of $300/yr
Net savings = $1600/yr – $300/yr = $1300/yr

Investments

No capital cost.

Payback

Immediate.

CF#2: Consider Upgrades to Cafeteria Facilities

Existing Conditions

The existing cafeteria/kitchen operations in the admin HQ Bldg #11 complex are in need of upgrades (Figure 29). The cafeteria is not air-conditioned, ventilation is poor with high negative pressure. The outside door to the wooden deck/patio lets smoke enter the cafeteria from a smoking area, the lighting system is old and inefficient and “spot” re-lamping is the current practice. Evaluation of the following during a Phase 2 assessment is recommended:

1. Air condition the cafeteria,
2. Improve ventilation in the kitchen w/VFDs,
3. Install a vestibule at outside door to deck
4. Upgrade lighting from T12s to T8s and
5. “Group” re-lamp rather than “spot” re-lamp.

Solution

Descriptive scope of recommendations:

1. Air condition the cafeteria as part of the "chiller project."
2. Install VFDs on ventilation system, which will reduce excessive air infiltration.
3. Install a vestibule on outside entrance from the deck (Figure 30).
4. Replace existing fluorescent fixtures with high efficiency ones.
5. "Group" re-lamp bldg #11 doing major areas at a time rather than "spot" re-lamping individual lamps as they burn out, several at a time. Labor savings of 80% or more.

Figure 29. Cafeteria in Building 11.

Figure 30. Cafeteria corner door lead to wood deck outside

Basis for Economic Calculations: Assumptions and Cost Basis of Savings (CBoS)

Time did not permit data collection. Economics will be developed during the Phase 2 Assessment.

Site-Wide Miscellaneous Improvement Recommendations

SW#1: Turn Off Unnecessary Site-Wide Electrical Loads To Reduce Site Wide KWH Cost During Non-Production Time

Existing Conditions

Many unnecessary loads are believed operating during non-production periods as a standard practice. Experience at many other DOD facilities has shown that a significant amount purchased electricity can be saved (5–15 percent or more) by identifying specific loads that can be safely manually turned off, initially at no cost and automatically scheduled off with an Energy Management Control System (EMCS) with some investment.

TYAD spends approx $3M/yr for electricity (58,763,000 kWh/yr at an average cost of 5.6¢/ kWh, includes ~$4.46/kW-month demand charge) from Pennsylvania Power and Light. We understand that there is no formal, proactive program to identify and turn off unnecessary operating loads during non-schedule periods throughout the week. We also understand that there is also no EMCS that can automatically monitor and control the use of general electrical loads when not needed (ventilation fans, lighting, air compressors, production equipment, etc.).

Solution

Savings from turning off unnecessary/non-critical loads can be achieved during two periods: First, during scheduled non-production time (2nd and/or 3rd shifts, weekends and holidays) saving kWh at 5.6¢/kWh and second, during on "peak" day shift. (Monday-Friday) to avoid paying peak demand charges ($4.46/kW per month). It is suggested that this initiative be implemented in two phases:

Phase A: Identify, "test" and initially manually turn off unnecessary loads during non-production periods and during peak demands time.

Phase B: Control these loads automatically with an EMCS to insure the "turn it off" program continues, tracking actual savings from the existing base case.

Basis for Economic Calculations: Assumptions and Cost Basis of Savings (CBoS)

1. TYAD electricity from PPL is understood to cost as follows
   a. Average annual per unit kwh (including peak demand) costs 5.6¢/kwh for 58,763,000/kwh/yr. ($3m/yr total bill)
   b. Peak demand cost approx $4.46/kw-mo. Typical peak kw throughout the year ranges from 9,000 kw to 10,000 + kw, averaging ~ 9500 kw annually. This says the demand component (kw) costs TYAD $9,500 kw x $4.46/kw-month x 12 months/yr = $508,440
   c. The average non-peak, base load consumption of kwh without a demand component is therefore $3,000,000/yr (total kwh + kw)-$508,440/yr (for kw)= $2,491,560. The value of reducing kwh during non-peak time is therefore $2,491,560 / 58,763,000 kwh or 4.24¢/kwh.

2. The site-wide kW demand varies as follows (based on graph of interval data for Dec.16, 2002 to Jan. 16, 2003):
   a. Peak demand, Mon–Fri: typically 8800-9800 kW, average approx. 9300 kW
   b. 2nd and 3rd shift loads, Mon-Fri: typically 5600-6200 kW, average approx. 5900 kW
   c. Weekend loads, Sat & Sun: typically 4800-5600 kW, average approx. 5200 kW
   d. Holiday load is typically 4600-5200 kW, average approx. 4900 kW
3. The following estimates are based on a 5% reduction in kWh reflect the "potential" savings from a manual "turn it off" solution, at no cost, and a 15% reduction in kWh from an EMCS "turn it off" solution with an investment in an EMCS.
4. The 10% of the typical 9300kW site wide demand is assumed to be controlled off with an EMCS during the peak each month.
5. A 200 point EMCS has an installed cost of $2000/point.

Solution

Phase A: Manual "Turn It Off"

base load kWh savings during 2nd and 3rd shift on weekdays is 5900 kW x 15h/d x 5d/wk x 50wk/yr x $0.0424/kWh x 5% saved = $46.9k/yr
base load kWh savings during weekends is 5200 kW x 20h/d x 2d/wk x 50wk/yr x $0.0424/kWh x 5% saved = $22.0k/yr
base load kWh savings during holidays is 4900 kW x 20hrs/holiday x 12 holidays/yr x $0.0424/kWh x 5% saved = $2.5k/yr
Totals for 1+ 2+ 3 = $46.9k + $22k + $2.5k = $71.4k/yr (a no cost solution)

Phase B: EMCS "Turn It Off"

Totals for the 5% above X 3 for a 15% savings factor = $214.2k/yr
Savings by reducing kW demand each month by 10% =
9300kW x 10% x $4.46/kW-month x 12months/yr = $49.8k/yr
Total savings with EMCS = A + B = $214.2k + 49.8k =$264k/yr

Investments

Total EMCS installed cost for 200 control points is $2000/point x 200 points = $400k

Payback

$400k/$264k/yr = 1.5 yrs

SW#2: Adopt Cogeneration

Existing Conditions

The facility has a large demand load placed on the electrical distribution grid, making it vulnerable to brownouts and blackouts. This facility experiences four brownouts/yr.

Issue

Brownouts create safety issues as well as halt production on many critical energy systems. With each brownout, the facility incurs many costs associated with bringing equipment online again. The facility has estimated the cost of brownout at $1.6 million dollars for each occurrence.

In general, electrical demand in the summer is higher than in the winter. The summer is when the facility has the greatest vulnerability to brownouts and blackouts. At the same time, this is when natural gas is less expensive due to decreased demand. This is because natural gas consumption increases in the winter and is reduced in the summer.

The facility uses natural gas to operate boilers supporting many of the buildings in terms of both process steam and space heating. The largest steam load is the heating load. The process steam load is substantially less.

Solution

It is recommended that the facility install a cogeneration system to produce power onsite and remove its dependence from the grid. Cogeneration allows for the generation of electrical energy onsite using another fuel source such as oil or natural gas. The installation requires the addition of a prime mover. The main benefit to a cogeneration system is the addition of a heat recovery off the prime mover. With the combined effect of electrical generation and heat recovery to supplement a thermal load, cogeneration can result in significant energy cost savings. Peak shaving with cogeneration will be able to eliminate the brownouts. The cost of brownouts makes cogeneration a very attractive option. Due to the different thermal requirements during the summer and winter, it is recommended that the facility consider seasonal strategies for power generation.

In the winter, the overall demand on the grid is lower and only peak shaving is required. During the winter the boiler load is the highest and allows for better options for heat recovery. It is recommended that the facility install a natural gas turbine to generate 6,000 kW of electricity. A natural gas turbine is capable of generating large electric loads and has great potential for heat recovery, even at the high steam pressures that this facility requires. Installing a natural gas turbine will enable the plant to reduce energy usage and costs in the winter.

Overall demand from the grid is high during the summer, which increases the chance of a brownout. It is recommended that the facility install several reciprocating engines ranging from 1,000 kW to 6,000 kW to generate 11,000 kW of electricity. Heat recovery is only going to be available for a few of these units because thermal demand is low during the summer. The benefit to installing several units is that the units can be operated to provide optimum levels of steam generation and electrical generation. In the summer, the boiler load is much lower and less heat recovery is available. The use of a natural gas fired turbine would yield excessive waste heat. The benefit of reciprocating engines over gas turbines is that the electrical generation is more efficient than that of the turbine when less waste heat recovery is required.

Implementation of this recommendation includes the purchase of reciprocating engines to supply backup power. It is possible to operate certain reciprocating engines with #2 fuel oil. The natural gas provider for this facility has agreed to reduce the natural gas price rate structure if the facility uses a certain amount of oil. This new rate plan was negotiated for using oil for a dual fueled boiler; however, the same rate should apply to the use of fuel oil by reciprocating engines, as it achieves the same result. Some of the backup engines can run on fuel oil and fill this requirement as well.

In addition, cogeneration will increase the level of force protection for the facility. In case of a man-made or natural event that disrupts electrical service, this facility would still be able to continue operations to support the war fighter. It would be in the facility's best interests to be self-sufficient for security, safety and production reasons.

Solution

The savings from installing a cogeneration system comes from avoided electricity purchases. Table 12 details the total annual cost savings to the facility.

Table 12. Cost savings from installing a cogeneration system.

Season	Winter	Summer	Total
Generation Capacity	6,000	11,000	---
Avoided Electricity Purchase	$1,710,000	$2,262,000	$3,972,000
Additional Natural Gas Purchase	($2,178,000)	($2,637,000)	($4,815,000)
Avoided Natural Gas Purchase From Boilers	$1,291,000	$155,000	$1,446,000
Operation and Maintenance Costs	($305,000)	($404,000)	($709,000)
Standby Charges	($18,000)	($33,000)	($51,000)
Utility Buy Back	$0	$311,000	$311,000
Brownout Savings	---	---	$6,400,400
Total Cost Savings	$500,000	($346,000)	$6,554,400

There are three major expenses that come with the installation of a cogeneration system: additional natural gas purchases, operation and maintenance costs, and the standby charges associated with having the grid ready to supply power if required. In the summer, the facility can sell back some electricity to the grid when it is over generating. It is important to understand that there is no direct cost savings associated with the installation of the reciprocating engines. It is more expensive to operate the cogeneration system than it is to purchase power from the grid in the summer. Combining the winter and summer savings will result in annual cost savings. The major source of savings is the avoidance of brownouts, totaling $6.4 million/yr.

Investments

The installation of a cogeneration system requires the purchase of a natural gas turbine and 12 reciprocating engines. The total costs and savings are displayed in Table 13.

Table 13. Cogeneration system cost savings and payback.

Cogeneration	Total
Total Cost Savings	$6,554,400
Total Implementation Cost	$36,000,000
Simple Payback	5.5 yrs

Payback

With an investment cost of $36 million and an annual savings of $6.5 million, the system will pay back in 5.5 years. It is recommended to conduct further investigation to confirm the estimated saving of brownout avoidance (approximately $1.6 millions per occurrence), which has the most significant economic impact.

SW#3: Install Back Pressure Steam Turbines

Existing Conditions

Steam at a pressure of 100 psig is supplied to the facility from boilers located in Buildings 1B and 1C. The steam is used for the electroplating lines in the IOF and for space heating in Buildings 1B and 1C. The electroplating lines require steam at 48 psig. Additionally, the space heating heat exchangers require steam at 28 psig. Therefore, the steam pressure is reduced in the steam lines by means of pressure reducing valves.

Issue

When steam pressure is reduced with pressure reducing valves, the energy of the steam is also reduced. Because the steam pressure is reduced with pressure reducing valves, this energy reduction results in a complete loss from the steam system. The energy loss of the steam due to the pressure reducing valves lowers the overall systematic efficiency of the steam system.

Solution

Install a dual stage extracting backpressure turbine for the boiler system in Building 1B and a backpressure turbine for the boiler system in Building 1C, each in parallel to the current pressure reducing valves. The steam could then be routed through the backpressure turbines instead of the pressure reducing valves. The steam entering the dual stage extracting backpressure turbine at 100 psig would be extracted at both 48 psig and 28 psig to account for both production and space heating needs. The backpressure turbine would only reduce the steam pressure from 100 psig to 28 psig.

The backpressure turbines would recover some of the energy lost from dropping the pressure in the steam distribution system. The turbines then would generate electricity that could be used by the facility. However, the steam would be at a lower quality after passing through the turbine compared to pressure reducing valves. As a result, the steam throughput of the distribution system would need to be increased to provide equivalent levels of heating.

Savings

Savings was estimated using the SSAT. The SSAT was programmed with input data gathered during the Phase 1 assessment, as well as the utility costs and the estimated condensate return percentages given by plant management. If the backpressure turbines were installed, the resulting electricity generated would reduce electrical costs by $106,000. However, the natural gas cost of the steam production would increase by $60,000, bringing the total cost savings to $46,000.

Investments

Initial estimates project an implementation cost of $600,000. However, accurate budget numbers will be based on measurements conducted during a Phase 2 assessment.

Payback

The expected simple payback period for this investment is 13 years.

SW#4: Install Magnehelic Gauge on Baghouse

Existing Conditions

The particulate that accumulates on the bag house filters is removed with intermittent pulses of compressed air. This cleans the filters to alleviate the static pressure buildup across the filter.

Issues

Releasing compressed air to the atmosphere is costly. Removing particulate from the bag house filters with intermittent pulses of compressed air is more energy efficient than a constant flow of compressed air. However, the pulses of compressed air are not controlled to respond to the static pressure across the filter. Therefore, more compressed air is used than necessary to assure the pressure build up across the filter is not too high.

Solution

Install a magnehelic gauge on the bag house. A magnehelic gauge measures the static pressure across the bag house filter and controls the compressed air used to clean the filter. The pulses of compressed air would then be released only when the static pressure across the filter reaches a specified level. The usage of compressed air would be limited to only the amount required. The electrical consumption of the air compressors would be minimized as a result.

Savings, Investments, and Payback

The idea of installing a magnehelic gauge was discovered only after the assessment team left the facility. If the facility is interested, greater detail, including cost, savings and payback, will be determined in the Phase 2 assessment.

SW#5: Install Electrical or Mechanical Lifts To Replace Pneumatic Vacuum Transport Device

Existing Conditions

The facility currently uses a pneumatic vacuum device to transport sheets of metal from one place to another.

Issue

Pneumatic vacuum devices use a large volume of compressed air. This is a considerable load on the compressed air system.

Solution

Due to the inherent inefficiencies of compressing air, the operation cost of an electric or mechanical lift is lower when compared to that of a pneumatic vacuum to lift the sheet metal. By switching to an electric lifting device, significant savings of electricity can be realized.

Savings, Investments, and Payback

The idea of installing electric or mechanical lifts was discovered only after the assessment team left the facility. If the facility is interested, greater detail, including cost, savings and payback, will be determined in the Phase 2 assessment.

SW#6: Replace Diaphragm Pumps with Electric Pumps

Existing Conditions

Many of the facility's pumps are driven by steam, but a portion of them are diaphragm pumps driven by compressed air. The primary use of the diaphragm pumps is for the transfer of the facility's wastewater.

issues

Diaphragm pumps are driven by compressed air. Compressed air is an inefficient power source, even if the compressors are well maintained. It typically requires eight times the electric energy consumption to drive pneumatic equipment as opposed to operating electrical driven equipment.

Solution

The diaphragm pumps can be replaced by electric motor pumps, which require less energy to operate, while providing comparable performance. Electric driven pumps do not require compressed air and instead use electricity as a power source. This avoids the inefficiencies associated with generating compressed air. As a result the compressors will operate at a decreased load, resulting in energy and cost savings.

Savings, Investments and Payback

The idea of replacing the diaphragm pumps with electric motor pumps was discovered only after the assessment team left the facility. If the facility is interested, greater detail, including cost, savings and payback, will be determined in the Phase 2 assessment.

4 Summary, Conclusions, and Recommendations

Summary of All Energy Conservation Measures (ECMs)

Of the 40 Energy Conservation Measures (ECMs) identified in this Phase 1 work, 22 were quantified with preliminary investment requirements (costs), estimated savings, and payback periods. Table 14 summarizes these 40 ECMs. Based on the savings category identified, each project funding source is suggested in the last column of the Table.

Conclusions

The Phase 1 Process and Energy Optimization Assessment at Tobyhanna Army Depot conducted a Level I analysis to determine the economic potential for significant energy and cost reduction opportunities. The study identified solutions to critical cost issues and estimated the economics for the top ideas. Forty ECMs were identified in the Phase 1 of the study (Table 14).

Economical quantification of 22 of the 40ECMs (Table 14) shows that, when implemented, the ECMs will allow TYAD to reduce its annual energy and operating costs by approximately $8.2M. The capital investment required to accomplish these savings is approximately $38.1M, indicating an average simple payback period of 4.6 yrs. If Cogeneration is excluded, then the savings is about $1.6M with a capital investment of approximately $2.1M, indicating an average simple payback period of 1.3 yrs (15 months).

Table 14. Investment, savings, and payback of 40ECMs.

ECM	Description	Investment (k$)	Savings (k$)	Payback (yrs)	Savings Category	Recommended Funding Source
PL#1	Replace existing control system in the Plating Shop	200	150	1.3	E,P	AWCF
PL#2	Recover heat from MAU steam vents in B-1E	100	345	0.3	E	ECIP
PL#3	Repair Auto Start/Stop Controls for 4 Scrubbers	30	193	0.2	E,P	ECIP
PL#4	Install a VFD on Scrubber PEF-3	20	23	0.8	E	ECIP
PN#1	Heat Recovery from Baking Ovens in Painting Shop	20	8.2	2.4	E	ECIP
PN#2	Install VFDs on Paint Booth Fan Motors	140	27.6	5.1	E	O&M
PN#3	Replace bag filters with roll filters	120	57.5	2.1	M	AWCF
WD#1	Improve exhaust extraction in Welding Shops and Motor Pool	129.9	TBD	Immediate	IAQ,P	AWCF
WD#2	Improve ventilation in Welding Shop, B-1A	30	TBD	TBD	IAQ	AWCF
BE#1	Install vestibules in IOF to reduce heating/cooling loads	TBD	TBD	TBD	E	ECIP
BE#2	Use White Roofs	0	6.8	Immediate	E	N/A
BH#1	Reduce heating in warehouses, B-2, 5, 6, 7 and 8	100	210	0.5	E	ECIP
BH#2	Improve radiant heater controls in B-15, vehicle washing	3.5	2.1	1.7	E	AWCF
BH#3	Improve controls of heating and ventilation in B-10	20	8	2.5	IAQ,P	AWCF
BH#4	Improve temperature control and heating and ventilation in B-14	10	4	2.5	E	AWCF
BH#5	Install gas-fired direct radiant heaters in B-1C, Bays 4-6	TBD	18	TBD	E,P	AWCF
BH#6	Improve controls and install cold air curtain at main door in B-23	TBD	TBD	<2	E	ECIP
BH#7	Optimize AHU running time and temperature settings Depot wide	TBD	TBD	<0.5	E	ECIP
BH#8	Stop heating B-96	0	TBD	Immediate	E	N/A
BH#9	Stop AHU heat circulation pumps in summertime	TBD	TBD	<0.1	E	AWCF
BH#10	Reduce outdoor air flows in AHUs, in winter and summer	TBD	TBD	TBD	E	O&M
BH#11	Shut down boiler, install radiant heater and fast door in B-55	100	100	1	E	DLA
BH#12	Renovate AHU in B-18	TBD	TBD	<1	E	O&M

ECM	Description	Investment (k$)	Savings (k$)	Payback (yrs)	Savings Category	Recommended Funding Source
BH#13	Use dedicated ventilation air distribution system for B-11 AC Project	TBD	TBD	TBD	M	AWCF
CP#1	Use Thermal Storage Tank for Chiller Plant	TBD	0.6	Immediate	E	AWCF
LT#1	Lighting Retrofit	TBD	TBD	TBD	E	ESPC
BP#1	Install Economizers on Boiler Stacks in B-1B, 1C	100	68.2	1.5	E	ECIP
BP#2	Use IOF Boiler to provide steam for B-1B, 1C and IOF	140	100	1.4	E	ECIP
CA#1	Use Engineered Compressed Air Nozzles	0.2	5	0.1	E	O&M
CA#2	Compressed Air Leaks Repair	TBD	30.5	<1	E	O&M
CA#3	Eliminate Inappropriate Compressed Air Usage	0	6	Immediate	E	N/A
CA#4	Install Zero Loss Air Trap Drain for the IOF Trim Compressor	0.1	2	0.1	E	O&M
CF#1	Consolidate walk-in cold food storage, use COG type-V-belts	0	1.3	Immediate	E	N/A
CF#2	Consider Upgrades to Cafeteria Facilities	TBD	TBD	TBD	E,M	AWCF
SW#1	Turn off unnecessary electrical loads sitewide	400	264	1.5	E	ESPC
SW#2	Adopt Cogeneration	36000	6554	5.5	E	ESPC
SW#3	Install Back Pressure Steam Turbines	600	46	13	E	ESPC
SW#4	Install Magnehelic Gauge on Baghouse	TBD	TBD	TBD	E,M	AWCF
SW#5	Install Electrical or Mechanical Lifts to replace Pneumatic Device	TBD	TBD	TBD	E	ESPC
SW#6	Replace Diaphragm Pumps with Electric Pumps	TBD	TBD	TBD	E	AWCF
	Total of the 22 economically quantified ECMs	38103.8	8181.7	4.6		
	Total of the 21 economically quantified ECMs, Without Cogeneration	2103.8	1627.7	1.3		

Note:

TBD = To be determined
E = Energy
P = Productivity
O&M = Operation & Maintenance Budget
ESPC = Energy Savings Performance Contract
N/A = Not Applicable
M = Maintenance
IAQ = Indoor Air Quality
ECIP = Energy Conservation Investment Program
AWCF = Army Working Capital Fund

Recommendations

The Level 1 analysis of multiple complex processes and systems conducted during the Phase 1 is not intended to be (nor should it be) very precise. The quantity and quality of the process improvements identified suggests that significant potential exists. It is recommended that TYAD accomplish these potential cost savings by pursuing an aggressive program of process optimization linked to the ongoing “LEAN” efforts.

It is also recommended that TYAD apply the identified low-cost/no-risk process improvement ideas from this analysis, which typically can be implemented quickly. However, the greatest profit opportunities need to be developed further by a Phase 2 effort, geared toward funds appropriation. This effort most often requires a combination of in-house and outside support.

It is recommended that TYAD pursue Phase 2 of this PEOA. Recommendations for the scope of the Phase 2 study can be based on the Phase 1 results presented in Table 14. A specific Phase 2 scope will be jointly developed by the CERL and TYAD teams through review and discussion of results documented in this Phase 1 report. Phase 2 will include a Level II analysis that “guesses at nothing – measures everything.” The results will be a set of demonstrated process and systems improvements based on hard numbers. CERL and expert consultants will provide guidance and further assistance in identifying a specific Phase 2 scope of work, respective roles, and the most expeditious implementation path. This will begin with a formal review of this (Phase 1) report, combined with a planning session to organize the Phase 2 program.

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Mike C.J. Lin, Alexander M. Zhivov, Alfred Woody, Curt Bjork, Walter P. Smith, Michael J. Chimack, and Robert A. Mille

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14. ABSTRACT

In February 2005, a team of expert consultants lead by researchers from the Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) performed a Level I Process and Energy Optimization Assessment (PEOA) at Tobyhanna Army Depot (TYAD) to identify process, energy, and environmental opportunities that could significantly improve the installation's mission readiness and competitive position. This assessment is a part of showcase studies at four sites selected by the Army Materiel Command to demonstrate energy reduction opportunities at industrial organic facilities and to promote the "Lean" concept and more efficient operations. The Level I analysis considered plating, painting, machining, welding, and mechanical repair shops, building envelope, heating, ventilation, air conditioning, and lighting. This report gives detailed results of the Level I study. The study recommended 40 (and economically quantified 22) process and energy improvement projects. An estimated $38.1M investment to implement these 22 projects at TYAD could achieve annual savings of $8.2M with an average simple payback of 4.6 years. If cogeneration (requires a very high capital investment and has a long payback time) is excluded, then the savings is about $1.6M with a capital investment of approximately $2.1M, indicating an average simple payback period of 1.3 yrs.

15. SUBJECT TERMS
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